CHEMISTRY

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LIBRARY

Wonder Drugs From Molds 1
Penicillin — Bacitracin
Streptomycin — Gramicidin
Lysozyme — Tomatin
Antibiotic Boxscore 18
Back Cover Picture:
Held at Bay 18
Tissue Chemical for Heart Ill 19
For the Home Lab:
Essence of Apples 21
New Sound in Liquid Helium 23
Hints for Your Lab:
Improved Condensers 24
Critical Chemicals 26
Petroleum Products Overcoming Shortages
Geology at Your Doorstep 36
Inventions Interesting to Chemists 39
Patents of the Month
Metabolite Antagonists 41
Dyes of the Primitives 44
How You Can Find Them
Editorial:
At the Molecular Level .....
Inside Front Cover

25¢

At the Molecular Level

➤ EVERYTHING from the rocks and the stars to the living creatures who o serve them can be classified at the molecular level as chemical phenomena. A one chemical to another, how do you feel this morning?

If you feel bright, brisk and happy, the reactions which keep you a goin concern are probably humming along with no more than the usual number unfavorable side reactions. If your grievances, fears and grudges make th world seem a terrible place, your blood-sugar level or the pH balance of you body fluids is probably more to blame than the Communist Party.

Slowly and painstakingly, for many years, scientists have been learning, b by bit, the way living mechanisms work. Once people, in scornful ignoranc refused to "believe in germs." They thought they couldn't be harmed by som thing too small for them to see. So the germs flourished at the expense o those cock-sure generations, and time and again mankind has been decimate by epidemics which threatened his extinction. Even now, political irrespons bles may be found mad enough to contemplate loosing new epidemics to gai temporary advantage for their side.

But the scientists' well-intentioned struggle to preserve for the human rac its niche in the natural scheme of things goes on. Learning how the lowe of organisms compete for existence, we can enter their lists and choose ou allies. By learning to provide the right environment for *penicillium notatu* and such friendly organisms, we can ensure a better environment for our ow lives and those of our neighbors all over the globe—a more rewarding strif than trying to extinguish our own species!

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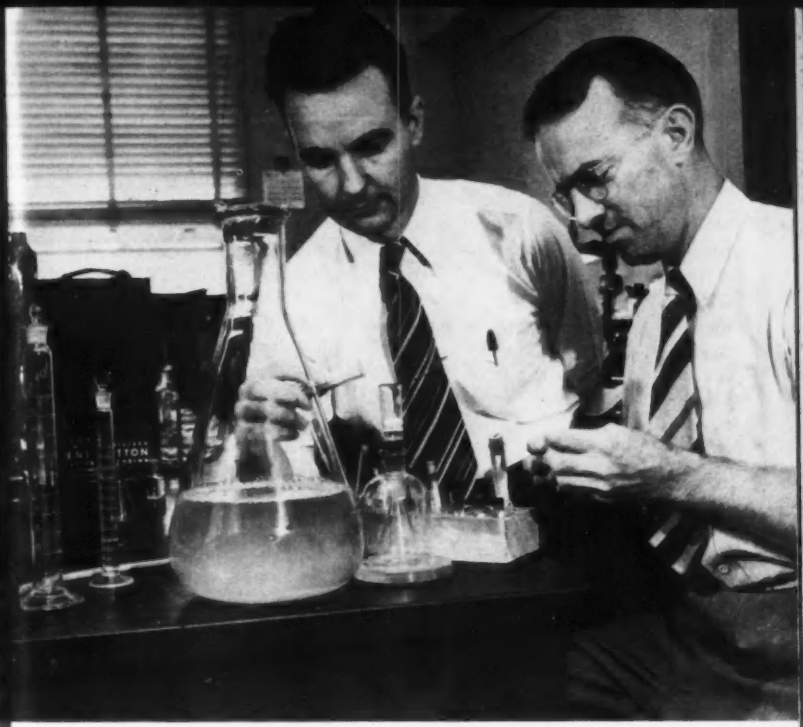

▶ TOMATIN, *germ-killing chemical extracted from dried tomato plants, is a new antibiotic discovered by Dr. T. D. Fontaine (left) and Dr. G. W. Irving, Jr., scientists of the U. S. Department of Agriculture, Beltsville, Md.*

Wonder Drugs From Molds

by JANE STAFFORD

▶ NEW CHEMICALS can save millions of human lives. There are new drugs, extracted from molds, yeasts, soil bacteria, and even from tomatoes and human tears.

Your doctor is already using two of these "antibiotics" as they are called. These are penicillin and streptomycin. And more antibiotics are on the way to the bedside of sick patients.

The new drugs fight epidemics and disease alongside the older medical weapons: vaccines, serums, and the sulfa drugs. When the sulfa drugs proved to be cures for unconquered diseases, like pneumonia and menin-

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gitis, they were called "wonder drugs."

The antibiotics deserve even more the same enthusiastic label.

The cures made by the new antibiotic drugs date from only a short time ago, but their origins are earlier.

Louis Pasteur, the great French scientist who is called the father of modern germ-fighting, 70 years ago made a discovery that the world heard little about. He wrote that it held great hope from the viewpoint of treating disease.

It was the discovery of the wonder substances known now as "antibiotics."

It was not one of his famous discoveries, like vaccination against rabies. Pasteur, himself, was not a practicing physician. So the world had to wait, while millions of men, women and children died of germ diseases, until another bacteriologist, who also was not a physician, made almost the same discovery in almost the same way. Even then the world had to wait until the worst of wars had started before these discoveries led to penicillin treatment of disease.

Pasteur's 1877 discovery was that anthrax germs could be stopped from growing by the germs that float in the air.

Pasteur went on to develop a vaccine against anthrax which protected sheep, cattle and other animals from the disease. This helped check the ravages of the nasty, deadly disease that humans got from infected animals or their hides or wool. Anthrax, the "Persian fire" of the ancients, continued, however, to attack man sporadically. American soldiers in the first World War got it from infected shaving brushes from Japan.

There was not much doctors could do for the victims of "Persian fire."

They gradually got well, or they died.

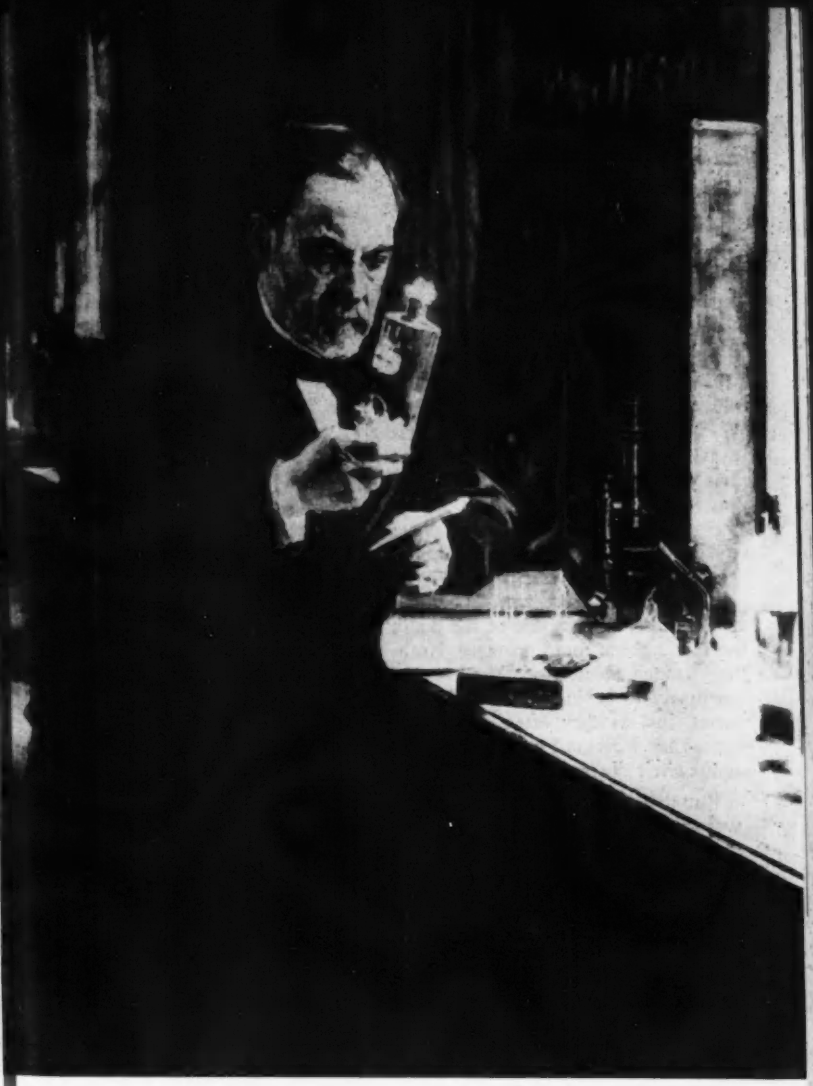
When the second World War started, anthrax was under suspicion as a disease the enemy might use if he got to fighting us with germs as well as bullets and bombs. It could kill livestock, needed for food, as well as humans.

Last summer, a report from a U. S. germ-warfare unit at Camp Detrick, Md., revealed that during the war 25 patients with anthrax were cured by penicillin. Pasteur's prediction had come true.

During the years between, Pasteur's observations had not been entirely forgotten. Other bacteriologists saw much the same thing he had seen—germs, or micro-organisms of some kind, killing off other micro-organisms.

American scientists by this time were also investigating the possibilities of using the germ-against-germ war, or microbial antagonism, to cure disease. At Rutgers University and the New Jersey Agricultural Experiment Station, Prof. Selman A. Waksman started on the road that led to penicillin's powerful ally in disease-fighting, streptomycin.

A young scientist of French birth, Dr. Rene J. Dubos, became interested while studying under Prof. Waksman. In 1939, in the midst of all the excitement over the new-found sulfa drugs, Dr. Dubos and Dr. Rollin D. Hotchkiss, both then at the Rockefeller Institute, extracted from soil



➤ Louis Pasteur *(1822-1895) made the first discovery of antibiotic action when he found, in 1877, that growth of anthrax germs could be stopped by other bacteria from the air.*

bacteria a chemical so powerful that one-millionth of an ounce would protect a mouse from a sure-death dose of pneumonia germs. This powerful anti-germ chemical was later named gramicidin. Its discovery was the result of a deliberate effort to turn the natural antagonism between microbes to mankind's advantage in his war on germs.

Penicillin's discovery was, by contrast, accidental. And it was made 10 years before the Dubos-Hotchkiss discovery made newspaper headlines. It all happened very quietly. There was Prof. Alexander Fleming, who has since become Sir Alexander, looking at some plates of agar in his laboratory. He was using the plates to grow staphylococci, the familiar germs that cause boils, food poisoning, and other sickness including blood poisoning. In one of the plates he saw a green mold growing. Nothing strange about that. Mold spores are likely to be in the air of laboratories, just as they often are in the air of kitchens and pantries, to the housewife's distress.

But then Prof. Fleming saw there was something a little strange. Staphylococci colonies growing in the neighborhood of the mold were dissolving. Another scientist might, in Prof. Fleming's place have shrugged his shoulders, dropped the mold-contaminated plate onto the pile of dirty "dishes" for the laboratory helper to boil and clean and sterilize, and written it off the record of the staphylococci study.

Prof. Fleming was undoubtedly alerted to catch any sign of dissolved bacteria. Seven years before he had discovered a substance in human tears that dissolves bacteria.

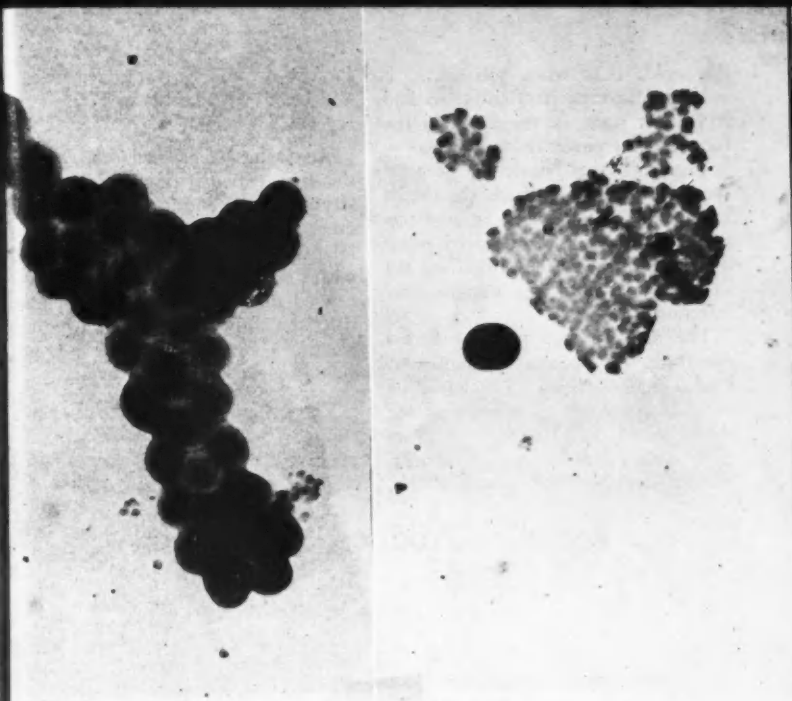
This substance, named lysozyme, led finally to the use of penicillin for treating disease.

Prof. Fleming kept the plate with the green mold on it. He grew the mold by itself and studied it. He identified it as Penicillium notatum, a fairly rare mold, not at all the kind you are likely to find on bread or cheese or fruit.

He found that this particular penicillium mold was hard to grow in the laboratory. It was choosey about its food. But Prof. Fleming persisted and finally extracted from the material on which it grew the chemical that dissolved bacteria. This he called penicillin. He tested it on many different bacteria.

Very minute amounts of it, he found, would check the growth not only of staphylococci but of streptococci, which cause much human sickness and death, and of many other bacteria. He also tried shooting some of the stuff into rabbits and mice, to see if it would kill them as well as the bacteria. It did not. It did not even hurt white blood cells, those natural and important germ-fighters in blood. When he finished his studies, he reported them in a scientific journal, pointing out that penicillin might be used as an antiseptic for putting on infected wounds.

Prof. Harold Raistrick and associates, P. W. Chutterbuck and R. Lovell, of the London School of Tropical Medicine, read this report. They worked at ways of producing penicillin in larger amounts. They studied its chemical make-up. Prof.



▶ STAPHYLOCOCCI, *shown as a flourishing colony in the electron microscope photograph on the left, are disrupted by action of penicillin to the condition shown in the photograph on the right.*

Raistrick tried to get his doctor friends to use it on patients, but did not succeed in this.

The sulfa drugs were discovered and saved lives and penicillin was almost forgotten.

Meanwhile a group of scientists at Oxford, under the leadership of Prof. A. H. Florey, now Sir Howard Florey, were looking into the possibilities of that other discovery of Prof. Fleming's, lysozyme. That chemical is found not only in tears but in almost all human tissues. The Oxford group purified it and learned more of its chemical nature.

Lysozyme led them to penicillin. While working on the anti-germ chemical in tears, Prof. Florey and Dr. E. Chain decided to make a systematic study of the anti-germ chemicals produced by microbes.

Penicillin looked like a poor choice for study in one way. It was hard to grow the mold. You could only get tiny amounts of the chemical from

the mold. And when you got it, it was hard to keep it. Conditions had to be just right, or the broth in the tubes lost the power to stop germs.

The fact that penicillin stopped staphylococci was perhaps the deciding factor in its choice. Sulfa drugs stopped streptococci and many other disease germs, but there was nothing known that would stop staphylococci infection.

The Oxford group labored for months, testing penicillin on mice as Prof. Fleming had. They labored more months getting enough of the yellow mold chemical to treat a patient—just one sick human patient. They called on Prof. Florey's wife, Dr. Mary E. Florey (Lady Florey) and Dr. C. M. Fletcher of Friern Emergency Hospital.

An Oxford policeman was one of the first patients. He had a severe staphylococcus infection. He and another patient began to get better, then relapsed. The same thing happened with two more patients. The amount needed to cure a man, calculated from the amount that cured a mouse, was not enough. And there was not enough penicillin to try again.

The results were encouraging enough, however, to make it "imperative" that larger supplies of penicillin be obtained.

Penicillin Produced in America

➤ THE WAR was on, and a medicine to fight staphylococci, chief deadly infection of war wounds, was badly needed. But English drug manufacturers, struggling through the blitz to make badly needed medicines of established worth, could not take on the job of making this new remedy from mold.

So Prof. Florey came to the United States. Here, scientists, government bureaus, drug manufacturers, distillers, took the mold, grew it in gallon jugs and carboys, in huge vats, found more productive strains of the mold, found better food for it, and produced the mold chemical by the million units, by the billion units, until there was enough penicillin to meet the ever-growing demand.

While a great second world war raged overseas, scientists were engaged in their own crucial battles against germs. From lowly organisms, they extracted and put to work two great germ-fighting chemicals.

Penicillin was a British discovery and an American production. Streptomycin was an American discovery and an American production. These two antibiotics, as they are called, fought diseases that the sulfa drugs, the wonder chemicals that came out of pre-Hitler Germany, could not not conquer. And just as penicillin is death to kinds of germs unaffected by sulfa drugs, so streptomycin takes up in disease fighting where penicillin leaves off.

The bedside battles fought with these wonder chemicals from molds are still recent. For instance, the first reported use of penicillin in America.

A 33-year-old man lay dying in a hospital bed at the Mayo Clinic, Rochester, Minn. Bacteremia was the medical diagnosis.

➤ Sir Alexander Fleming, *British scientist, who discovered penicillin in mold and lysozyme in human tears and tissues.*

His illness had started with a soreness on the right side of his nose. Within a week the entire side of his face was swollen, red and painful. The side of his nose was discharging pus. Both eyelids were red and swollen. His right eye was cocked down and outward and he could not move it normally. His temperature was 104 degrees Fahrenheit.

He was given the best treatment of the time, 1942. Nurses kept hot moist packs on his face and the doctors prescribed sulfadiazine.

In spite of this his condition grew worse. He could not open his eyes, his face was so swollen.

Meanwhile, a sample of his blood had been sent to the laboratory. The report came back: Staphylococci in the blood.

The doctors read that report and ordered the sulfadiazine stopped. Sulfa drugs were no good against staphylococci. But there was penicillin, a new drug, extracted from a mold that British doctors had reported would check these "staph"

germs, and the Mayo Clinic had some of it.

Doctors in charge of this blood-poisoning case started giving this penicillin to their patient. Each 24 hours for two days, some two quarts of salt solution containing penicillin were dripped into the man's veins at the rate of 25 to 30 drops per minute.

Within 22 hours after starting this new treatment, the "staph" germs had disappeared from his blood. Two hours later his temperature had dropped to 100 degrees Fahrenheit. He felt better and was able to eat well, though he still could not open his eyes. After six days of treatment his temperature was normal, he could open and move both eyes, and except for loss of vision in his right eye, appeared and felt well. The loss of vision was believed due to swelling of the orbit which damaged the optic nerve.

His doctors, W. E. Herrell, Dorothy M. Heilman, and H. L. Williams, cautiously stated: "It seems likely that penicillin was responsible for the recovery of the patient."

Other doctors read that report eagerly. It was the first report to appear in the United States of a patient given that kind of penicillin treatment. A few other doctors had been working with penicillin in the United States after reading the English reports. Among these were Drs. Martin H. Dawson, Karl Meyer, Gladys L. Hobby and Eleanor Chaffee of Columbia University, but they had not yet published reports of their use of it in treating patients.

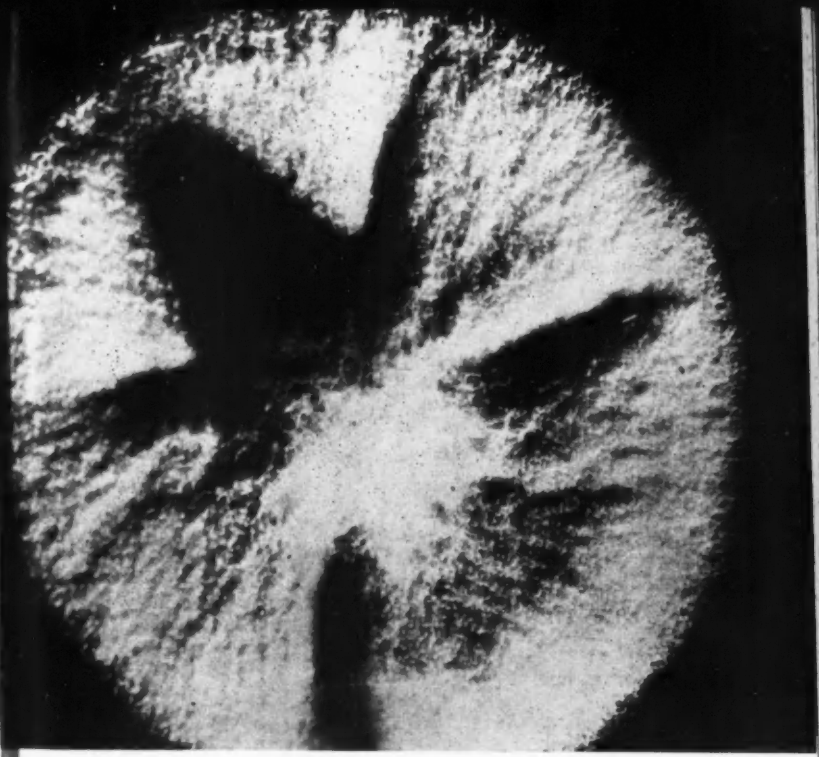
At the Johns Hopkins Hospital, where the sulfa drugs a few years earlier had gotten their American start, Drs. J. E. Bordley, S. J. Crowe, D. A. Dolowtiz and K. L. Pickrell had been using penicillin to irrigate wounds. Their report was published at the same time as the one from the Mayo Clinic.

These first American investigators had to make their own penicillin, an arduous job. Their successes and the British experience showed that the yellow powder, born of greenish mold, was one of the essentials of fighting disease. War spurred penicillin production on an extraordinary scale but penicillin went into military service so completely that doctors could get little of it for civilian patients, even to save lives.

Penicillin had been discovered by accident by British investigators. The other major antibiotic, streptomycin, by contrast, had literally to be dug out of the earth. The American investigators knew pretty well what they wanted. It took five years of hard digging and searching to get it, but the reward was worth the effort. Streptomycin, besides other germ fighting powers, is the best medical weapon against tuberculosis yet found.

This down to earth searching for a weapon against disease germs was an idea of Dr. Selman A. Waksman, microbiologist of the New Jersey State Agricultural Experiment Station. The earth's teeming microbes convert waste into food for plant and animal life. In them, Dr. Waksman found microbial antagonisms which might prove useful in man's fight against germ-caused diseases.

As long ago as 1940 Dr. Waks-



➤ PENICILLIUM NOTATUM, *the green mold from which the yellow antibiotic chemical penicillin, is obtained. Penicillin will check staphylococci, against which sulfa drugs are helpless.*

man reported to the National Academy of Sciences some results of his earth-searching for new weapons against disease germs.

The substance reported then did not turn out to be what the doctors needed to get people well of ailments not susceptible to attack by the sulfa drugs. Not even penicillin, when it was rescued from oblivion and turned to disease-fighting, could stop the onslaught on human bodies of tubercle bacilli or of disease germs belonging to the group labeled "gram negative."

So, Dr. Waksman, aided by numerous collaborators and students, continued his searching and digging.

From normal soils, enriched soils, composts, manures and peat bogs, Dr. Waksman and fellow workers in his laboratory isolated bacteria, ac-

tinomycetes and fungi, and examined them for antibiotic production. Of the thousands of microbes studied, the actinomycetes showed most promise. These are neither molds nor bacteria but occupy an intermediary position between the two. Like bacteria in many ways, they have thread-like, branching bodies like molds.

From one of these actinomycetes Dr. Waksman and his group in 1940 turned up an antibiotic which they named actinomycin. It was effective against many germs but it was also poisonous to the human body, so it had to be put aside.

Next they isolated from molds two compounds which they designated as clavacin and fumigacin. The first of these also proved to be quite toxic, while the second was not as active as they would have liked. Then came two more named chaetomin and micromonosporin. Chaetomin would attack germs in glass vessels but was not active in the human body. Micromonosporin had only limited activity even in the test tube.

Finally they isolated a substance which they called streptothricin. It appeared to have the antibiotic properties that they were looking for. It would attack the gram-negative bacteria the sulfa drugs affected little or not at all.

Upon careful investigation of the pharmacological properties of streptothricin, it was found to leave a residual effect in the body which could in time become quite harmful. So it was put aside.

Undaunted by this failure which had been so heartbreakingly close to being a success, Dr. Waksman and his collaborators searched further. Finally they discovered a culture of one kind of actinomyces, Streptomyces griseus, from which was isolated the new, powerful antibiotic, streptomycin.

Now both penicillin and streptomycin can be obtained at the drug store on doctors' prescription. Each of these new wonder drugs has its own kind of jobs to do. One supplements the other.

Penicillin mows down the "staph" germs that are great killers. It virtually conquers the venereal diseases in a few days.

Streptomycin is medicine's first real hope for a chemical cure of tuberculosis. And plague, the black death of the Middle Ages, which still flares up today, is the latest streptomycin conquest.

Many Diseases Conquered

➤ PUT THESE dreadful diseases, deadly killers through the ages, on the list of those virtually conquered:

Plague, gonorrhea, syphilis, anthrax, "blood poisoning," many kinds of pneumonia and empyema, meningitis, mastoiditis, and other staphylococcus and hemolytic streptococcus infections.

These and other conquests have been made by penicillin, the yellow mold chemical and its antibiotic ally streptomycin.

For the future this means the saving of millions of lives.

Equally important, perhaps, there is hope that streptomycin is the chemical weapon that will conquer tuberculosis.

▶ Dr. Selman A. Waksman, *American microbiologist, who discovered streptomycin and numerous other antibiotics.*

Some diseases from which almost no one ever recovered have had their death rates reduced to one out of four or less. All patients with anthrax recover promptly.

Pneumonia, once a great killer, now, thanks to the sulfa drugs as well as the new antibiotic chemicals, is only 5% fatal.

In addition to being effective in treating dangerous diseases, penicillin has proved its value in prevention of infection in wounds and burns, in chest surgery and for the prevention of blood poisoning following tooth extraction.

Syphilis and gonorrhea, twin scourges of armies and civilian populations, were among the first to go down before the yellow mold chemical. One-day cures of gonorrhea, eight-day recoveries from syphilis were achieved.

The speed of these recoveries was only one amazing feature of penicillin treatment. The other was its safety.

A few daring physicians had been

condensing syphilis treatment into one, two or three weeks, instead of 18 months. But they did it by giving huge doses of arsenicals, a potentially dangerous procedure and one that could not be undertaken in all cases. Sulfa drugs had been curing gonorrhea, but a few patients had severe reactions to these drugs. They were not killers as arsenic could be, but the reactions at times were bad enough to call a halt to their use, whether or not the patient had recovered.

The two principal venereal diseases can be controlled by penicillin alone if treatment is started early enough. This is the medical verdict.

Latest addition to the life-saving achievements of antibiotics is the predicted triumph of streptomycin over plague. Streptomycin, Dr. Karl F. Meyer, University of California epidemiologist, announced this year, controls pneumonic plague in 90% of mice given the chemical.

Pneumonic plague is the most deadly form of this ancient scourge which was the "Black Death" of the Middle Ages and which still occurs routinely in China and India. "There is every reason to believe that streptomycin will be equally effective in man if given early in the attacks of plague," Dr. Meyer stated in reporting the mouse cures.

The findings indicate to Dr. Meyer the last threat of this disease has been removed in modern nations.

Hopeful as Tuberculosis Foe

➤ MOST EXCITING of all streptomycin triumphs is its victory in tuberculosis.

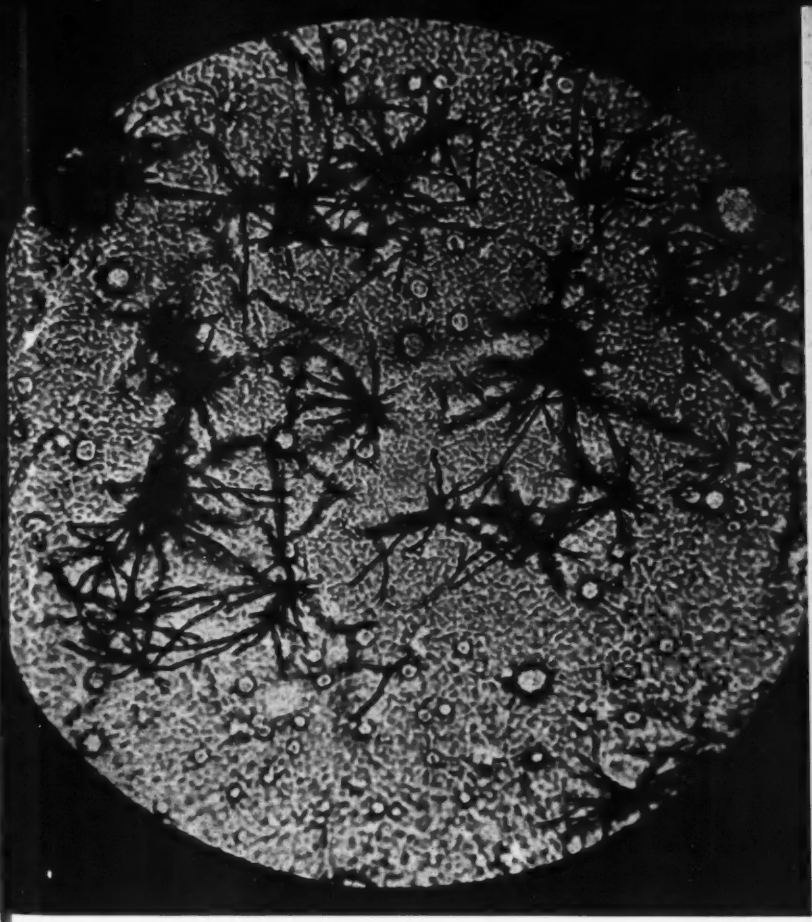
Even the doctors, who have seen so many promising weapons against the great white plague fail, are now frankly excited. They call it "the first real lead toward the conquest of tuberculosis."

Patients who, by all ordinary standards, should be dead are now alive, thanks to streptomycin. Some of these suffered from miliary (not military) tuberculosis. The word comes from the Latin word miliaris, meaning like a millet seed. Spread by the blood stream from the lungs throughout the body, the TB germs scatter millet seed-like sores. Every organ may be affected. In some cases the germs attack the membranes covering the brain. This is tuberculous meningitis.

Others are patients who could be saved by surgery but who were so desperately ill no surgeon would dare operate. Streptomycin by itself did not cure them, but it got the disease under control. The patients got enough better so the surgeon could cut into their chests and perform whatever operation was needed to put the sick lung at rest. From then on their chances for recovery were good.

There is the case of the 19-year old girl who had rapidly progressive tuberculosis of the lymph glands in her neck. Within three months the germs had attacked the membranes or sac around her heart. She was acutely ill but because of the heart condition could not lie flat in bed.

Before streptomycin, only a few patients ever got over tuberculosis of this kind. Within five days after



▶ STREPTOMYCIN GRISEUS *forms the spidery-looking bodies, between molds and bacteria, from which the antibiotic streptomycin is extracted. Streptomycin is active against germs not controlled by penicillin.*

streptomycin treatment was started, this girl's high temperature had dropped and her symptoms "completely and dramatically" disappeared. So had the germs which had been found in the fluid around the heart, in the lymph glands and in her blood. Five months after treatment she was without fever or other symptoms, and living at home where

she could be up and about at least part of the day.

The medical excitement about streptomycin and TB was bubbling under the surface for about two years. Five months after streptomycin was announced a very cautious report came from Drs. W. H. Feldman and H. Corwin Hinshaw of the Mayo Clinic. Dr. Waksman, discoverer of streptomycin, had found that it stopped TB germs, among others, in the test tube. The Mayo Clinic group had been testing many chemicals as possible weapons against TB. Included were sulfa drugs and chemicals related to them, such as promin and promizole. So, Dr. Waksman suggested that they try his new earth mold chemical.

They did. In January, 1945, they reported that streptomycin had a "striking suppressive effect" on tuberculosis in guinea pigs. It did not have any harmful effect on the animals. Doses of human TB germs that ordinarily caused widespread and destructive tuberculosis in the bodies of guinea pigs caused hardly any detectable signs of disease in animals that got daily doses of streptomycin. The report did not say a word about tuberculosis in humans.

Word got around on the medical grapevine, however. One of these new mold chemicals was being given to TB patients. They were getting well.

Finally, in September, 1945, came the first report of the human trials of the drug. It had been given to 34 patients. It had a "limited suppressive effect" on the disease, especially in some of the more unusual types of tuberculosis.

Then, and now even after experience in streptomycin treatment of hundreds of patients, the doctors urge a certain amount of caution. But they have grown increasingly enthusiastic. They still stress that streptomycin is not a cure for every case of TB and that it may not be possible for every patient with TB to get it at present.

One important limiting factor in its use is the high cost of the chemical. The patient must get streptomycin every day for from four to eight weeks, at a cost of $5 to $10 a day for the chemical alone.

Many patients can get over tuberculosis without streptomycin, as thousands have in the past.

Few doctors have as yet had much experience in using streptomycin for tuberculosis. As with any new drug, many doctors will hesitate to use it until they have a chance to learn all about it. Thousands of them crowded the exhibits on streptomycin and tuberculosis at the recent meeting of the American Medical Association. They asked the experts there countless questions about size of dose, reactions, type of patient who should get it, resistance and so on.

Reactions and resistance are a couple of other stumbling blocks in streptomycin treatment of tuberculosis. Various disease germs sometimes get resistant to streptomycin, as they do to penicillin. Then the drug is no longer effective. Some patients given streptomycin for tuberculosis have gotten vertigo, which is a kind of dizziness, and other signs of ear trouble, including deafness.

Both these stumbling blocks have been exaggerated, in the opinion of

one leading authority. The reactions and the resistance do not happen very often. Some of them, he said, may have occurred because the doctor was using too much of the drug.

After sulfa drugs, penicillin, streptomycin—what comes next in medicine's war against germs?

Many diseases remain unconquered. Among them are the virus diseases, such as the common cold, influenza, infantile paralysis.

From molds and yeasts and bacteria in the air and in the earth, from plants and human tears and saliva scientists are busily extracting chemicals that they hope will conquer the remaining germs that plague mankind.

Bacitracin Conquers Boils

▶ BACITRACIN is one of the exciting newcomers. It was discovered by a group of scientists at Columbia University.

Patients with boils, carbuncles, abscesses, styes and ulcers will not have to have these lanced or cut, if they get bacitracin. In its first trials, this anti-germ chemical saved 62 out of 100 patients from having to undergo surgery.

Particularly striking was the result in a dangerous abscess of the face below the lower lid near the outer side of the left eye. A red, hard area pointed in a triangular fashion toward the inner angle of the eye on the nose side. Bacitracin solution was injected into the abscess. Twenty-four hours later the pointing triangle had receded and the danger of germs invading the boy's skull and brain had passed.

Bacitracin scored another success in a patient with a deep abscess of the cheek. The abscess measured about an inch and a half in diameter. Pus was sucked out of the abscess with a needle and bacitracin injected on two successive days. On the fourth day the swelling was all gone and there was no need to cut the abscess.

If surgery is needed for abscesses and the like, bacitracin can help speed healing.

It was originally obtained from a germ from a badly infected wound in a girl who had broken the bone on the inside of the leg below the knee. The girl's last name was Tracy and the germ was a bacillus, so the healing chemical was given a name from parts of each word, bacitracin.

Bacitracin was discovered by Dr. Frank L. Meleney and Miss Balbina Johnson, of Columbia University's College of Physicians and Surgeons. It was no chance discovery. The Columbia scientists were looking for evidence of germ-fighting-germ action in badly infected civilian accident wounds. Such action was suspected from the fact that badly infected war wounds often did very well when sealed in a plaster cast without any antiseptic.

At first, Dr. Meleney only used bacitracin locally, injecting it into an abscess or boil or applying it as a salve. The material has recently become available in a form suitable for injection into muscles, as penicillin is given. This may extend its useful-

ness to conditions other than boils and the like.

Many old-time remedies are due for a scientific revival as the search for more germ-against-germ chemicals is pushed. Many of these, and many practices in surgery, Dr. Waksman points out, are based on the creation of conditions favorable to the development of this germ-against-germ war.

For example: Grandmothers and great-grandmothers who dosed the family with ginger tea had something, it now appears. Scientists at the Winthrop Chemical Company discovered two antibiotics in wild ginger. One of these anti-germ chemicals is a colorless compound active against pus-forming germs. The other is a lemon-yellow acid, but has less anti-germ activity.

Dr. C. J. Cavallito and associates at Winthrop who discovered the anti-germ chemicals in wild ginger also have isolated an anti-germ chemical from common garlic. They call this allicin, taking the word from the technical name for the common garlic plant, Allium sativum. Allicin may be the basis for the old folk-belief that garlic and onions were good medicine for colds.

Flour made from soy beans and jack beans has yielded an antibiotic called canavalin.

The tear chemical, lysozyme, that Dr. Alexander Fleming (now Sir Alexander Fleming) studied on the way to discovery of penicillin, is a powerful anti-germ substance. It is found not only in tears but all other body fluids except normal urine, cerebrospinal fluid and sweat. It is not likely, however, to become a chemical remedy because it is an enzyme and chemicals of the enzyme group are not particularly suitable for treating infections.

Tomatin Against Fungi

► TOMATOES, refreshing and vitamin C-rich food, turn out to have value in the war against germs. Germs of athlete's foot can be knocked out with tomato juice. Not the red kind that comes in cans, but the juice pressed from leaves and stems of the tomato plant, chemically freed of its green coloring-matter and concentrated. The active principle has been named tomatin.

This discovery was made by two U. S. Department of Agriculture scientists, working at the Department's great experiment station at Beltsville, Md. The men are Dr. G. W. Irving, Jr., and Dr. T. D. Fontaine.

Besides the athlete's foot-fungi, tomatin has been found effective in stopping the growth of various other fungi and parasitic yeasts that cause disease in human beings and animals, including the fungi that produce skin and scalp ringworm. Tests have been on cultures of the organisms themselves, in glass vessels.

Tomatin was discovered in 1946 as a result of a search for the reason why some tomato plants are resistant to fungus disease attacks and others are not. It was abundant in resistant plants; susceptible ones had little or none of it.

Since then, tomatin-like action has

been obtained from leaf juices of potatoes and green peppers, which are botanically related to tomatoes, also in the juices of cabbages and sweet potatoes, which are not. Juices of other garden plants have been tested, but none have shown activity.

It takes a half-ton of dried leaves of tomato plants to give 15 grams (about half an ounce) of tomatin.

About pronouncing the name of the antibiotic from tomatoes: It is tom-a-tin with the accent on tom, pronounced like the boy's name, and the rest is just plain "a" and "tin," like the name of the metal.

Plants as well as humans may be helped by germ-against-germ chemicals. Subtilin, a chemical from the microbe called B. subtilis, was first reported effective, in laboratory experiments, against such human germ-caused diseases as anthrax, pneumonia and tuberculosis. Latest report on it is that it can successfully attack bacteria that lurk in the coats of seeds and attack young plants when they begin to sprout.

Most of these new antibiotics, potential allies of penicillin and streptomycin, are so new that their role in disease-fighting has not yet been fully learned. Already there are more than 60 of them, and probably many more will be discovered.

The object of the search is not alone to find germ-against-germ chemicals that will prove remedies for unconquered diseases. There is the hope that some of the new ones can take over, if penicillin and streptomycin outlive their usefulness because too many strains of germs have developed resistance to them.

Gramicidin, one of the first antibiotics, is being tested now with that object in view. The idea is that gramicidin could be used for surface infections, where it can be safely used, reserving penicillin for cases where the antibiotic must be injected into the body to save life.

The searching is not all being done by bacteriologists. Chemists are at work, too, trying to find ways of creating in the laboratory synthetic mold chemicals. Penicillin has been synthesized, with much labor. The amount obtained however, is so small that synthesis on a practical scale is still a dream and a hope.

Sir Robert Robertson, professor of chemistry at Oxford and one of the chemists who worked toward synthesis of penicillin, explains the situation as follows:

"Penicillin possesses a curious strained structure, unique among natural products, and this endows it with such re-activity that all the chemical processes so far tried have proved too brutal. The molecule is of course stable enough to exist but it is easily thrown off its balance.

"A ball can rest on a narrow shelf but if that is narrow enough and high enough it might be possible to find that the attempt to throw the ball on the shelf, so that it would remain there, would succeed only once in a thousand times. It seems that our chemical processes are too energetic and we have no equivalent to the certain method of placing the ball on the shelf by hand."

There is very little doubt of eventual success of the chemists, perhaps by studying the operation of the mold itself and then imitating it, though they may be beaten momentarily.

Antibiotic Boxscore

➤ THE medical box score on penicillin and streptomycin in reduction of deaths per 100 cases of serious infections, or germ-caused diseases is given by Dr. Chester S. Keefer, of Boston University:

Staphylococcus infections, once 80% to 85% fatal, now 25%.

Cavernous sinus thrombosis, once 100% fatal, now 15 to 30%.

Hemolytic streptococcus infections, once 80% fatal, now 20%.

Pneumonia, now less than 5%.

Mediastinitis, once 98%, now 15%.

Gram negative bacillary infections, once 60%, now 10%.

Influenza bacillus meningitis, once 98%, now 30%.

"Striking results" with recovery rates now about 70% have been chalked up for non-hemolytic streptococcus infections exclusive of bacterial endocarditis.

In gonorrhea and syphilis results "continue to be outstanding and there is no reason to believe that these diseases cannot be controlled by penicillin alone if treatment is started early," Dr. Keefer declared.

All patients with anthrax now recover promptly. Three-fourths of those with gas gangrene recover and 90% of those with rat bite fever. The death rate in all types of tularemia is reduced and the duration of disease shortened by streptomycin.

For meningitis, the recovery rates are 60% to 70% when the disease is caused by the pneumococci, staphylococci and streptococci. At least half of patients with infections associated with agranulocytosis now recover with penicillin.

In addition to all this, penicillin has proved its value in prevention of infection in wounds, and burns, in chest surgery and for prevention of blood poisoning following tooth extraction.

These are but a few of the diseases controlled by remedies that were not available for practical use until four years ago.

In the future even better chemical remedies can be expected, Dr. Keefer suggested. He pointed to the need for agents effective against virus infections and cancer and to the fact that many new antibiotics are now being investigated.

On the Back Cover

➤ FIVE TESTS *for antibiotic activity. Micro-organisms are growing all over the plate except where kept at bay by the five antibiotics spotted on. Diameters of the clear dark circles give a measure of the power of these mold chemicals to check growth of bacteria.*

Cytochrome C Helps Utilization of Oxygen

Tissue Chemical for Heart Ill

▶ A LIVING TISSUE chemical given by injection promises new relief for sufferers from painful heart disease and perhaps for hardening of the arteries.

It may rescue some from mental disorders due to oxygen lack. Called cytochrome C, the new chemical treatment is reported by Drs. Samuel Proger and D. Dekaneas of Tufts Medical College and the Pratt Diagnostic Hospital of Boston.

Patients have already been helped. Angina pectoris has been relieved. Some unable to take more than a few steps because of excruciating pain in the legs, due to a condition known as intermittent claudication, have walked without pain.

In one patient with another kind of illness, results have been so striking the doctors are afraid to publish them, even in medical journals, until they have had time to try the treatment on more patients.

The treatment consists of injections of a chemical called cytochrome C. This is a protein normally present in the body and in fact in all living tissue, plant or animal. It is not poisonous so can be safely used, perhaps even in quite large single doses. Its normal function is to promote utilization of oxygen by body tissues.

This is the reason for its effectiveness in probably a wide variety of serious diseases. Lack of oxygen in the cells of blood vessels and various other body tissues is the common underlying cause of many disorders, from the black-outs of pilots during the war to angina pectoris, certain mental disorders and poisoning from over-doses of barbiturate sleeping medicines.

In conditions of oxygen lack, even so severe that the patient is barely conscious, the Boston doctors point out there is considerable oxygen circulating in the blood in the veins. A way to help the tissues use this oxygen, they reasoned, might save the patient.

Giving cytochrome C seems to be the way. An increase of oxygen consumption of 50% to 100% can be achieved with the aid of this chemical, they found in test tube experiments.

Possibilities of the chemical's usefulness in mental disorders, if due to lack of oxygen, appeared in tests in the pressure chamber used in wartime studies of oxygen lack at high altitude. Dr. Proger found from personal experience in one of these pressure chambers at the Harvard Fatigue Laboratory how ability to see clearly and think quickly is impaired by oxygen lack and how this can be overcome, without supplying any extra oxygen, by a dose of cytochrome C. Mental deterioration that comes with hardening of the arteries of the brain may result from lack of oxygen because the hardened, narrowed arteries cannot supply enough oxygen-containing blood to the brain cells. Cytochrome C might help in such cases. Epilepsy and migraine headaches are other disorders that might be helped.

Antibiotic From Rabbit Blood

➤ A NEW penicillin-like drug extracted from the red blood cells of rabbits and other animals is now under clinical trial as a weapon against diphtheria in several Moscow clinics.

First-hand account of this new development in disease-fighting is being given American scientists by Dr. Vassily V. Parin, secretary general of the Academy of Medical Sciences of the USSR and professor of physiology at the Third Moscow Medical Institute. Dr. Parin visited the United States at the invitation of Surgeon General Thomas Parren, U. S. Public Health Service.

Erythrin is the name of the new antibiotic. It is the first such substance extracted from higher animals. Penicillin comes from a mold and the famous KR anti-cancer vaccine under trial in Russia comes from a protozoön, but this form of animal life is very low in the animal kingdom.

The new antibiotic from rabbit blood cells was discovered by Dr. L. A. Silber of Moscow. It is very effective against different kinds of disease germs and particularly against the germs of diphtheria.

Diphtheria patients and healthy carriers of diphtheria germs are at present being treated with erythrin. The antibiotic gets its name from the medical name for red blood cells, erythrocytes. Red cells from other common laboratory animals, such as guinea pigs and white rats, also are sources of the substance but Dr. Silber has found the erythricin from rabbits the most effective.

A whole new branch of the science of antibiotics may be opening as a result of this discovery.

Unbalanced Equations

Metaphorically Speaking

➤ IN A COMPLEX problem, such as cancer, their first year has largely been occupied in bringing the new "big guns" up to the front for attack. The initial basic spade work accomplished this year by many isotope investigators will certainly lead to increasing harvests of results in the future.

—United States Atomic Energy Commission: Background Material on Activity in First Year of Distribution of Pile-Produced Radioisotopes. August 3, 1947. (p. 12)

For the Home Lab

Essence of Apples

by Burton L. Hawk

"Say, old chum, how about combining our brilliant minds to prepare that apple concoction you were talking about the other day?"

"A good idea, Jack, now that we have some time to spend in the Lab. Now let's see, what was the name of that stuff? Ethyl . . . ethyl something."

"Can't think of ethyl's last name? How about acetate, salicylate, butyrate, oxalate, valerate . . ."

"Ethyl valerate . . . *iso*valerate. That's it! Ethyl isovalerate . . . 'colorless liquid with apple-like odor.' Sound interesting?"

"Quite. I hate to throw in a wet blanket . . . but just how in the world do we prepare same?"

"Here is where we use aforementioned brilliant mind. We know ethyl isovalerate is an ester similar to ethyl acetate . . . right?"

"Right."

"And we know that ethyl acetate is prepared by the combination of ethyl alcohol and acetic acid?"

"Granted."

"Then is it not in order to assume that the isovalerate ester is prepared by the combination of ethyl alcohol with *isovaleric acid*?"

"What excellent showing of intelligence, old boy! That's downright astoundin'! Just one minor detail I must add."

"Elucidate, fellow scientist."

"We have no isovaleric acid."

"Is that all? Don't let a little thing like that trouble you! We simply prepare our own. Referring to prior conversation on ethyl acetate . . . suppose we had no acetic acid. We could prepare some by oxidation of ethyl alcohol, could we not?"

"Right."

"Well, then, we can prepare isovaleric acid by oxidation of . . . of . . . er—let's see . . ."

"Go ahead . . . oxidation of which alcohol?"

"Pardon slight pause for identification. Here it is, formula for isovaleric acid is $(CH_3)_2.CH.CH_2.COOH$."

"So?"

"So, let us scan the formulas of the more popular alcohols. Do you note any similarity?"

"Ah, yes. The light is beginning to break through. There is iso-amyl alcohol with the formula $(CH_3)_2.CH.CH_2.CH_2.OH$."

"Precisely, old chap. Now fortunately, we can formulate our formula thusly: $(CH_3)_2.CH.CH_2.CH_2.OH + 2(O) \rightarrow (CH_3)_2.CH.CH_2.COOH + H_2O$."

"Good. Now let's stop fooling around and start actual work on the project. I assume chromic acid would be the proper oxidizing agent."

"Absolutely the best. We'll place about 10 cc. of water in the flask and add just about as much sulfuric acid. Now if you will weigh out seven grams of potassium bichromate and add it to the solution . . ."

"No sooner said than done. Now we dissolve, and lo, the chromic acid is ready! Amazin,' eh what?"

"Quite. Now about 3 cc. of isoamyl alcohol should be enough. I hear these reactions are quite vigorous, so I suggest we add the alcohol drop by drop, and shake the flask thoroughly after each addition."

"You are right again. Old chromic acid really goes to town with its oxidation. That flask is really hot! Whew, what an odor!"

"So far so good. Notice the solution is turning green. We had better cool the flask a bit. Immerse it in cold water."

"This certainly doesn't smell like apples to me! More like rancid cheese . . ."

"That's fine . . . just what we want. The cheesey odor is valeric acid. If all the alcohol has been added, heat the mess for about five or ten minutes."

"Open that window! What an odor! How in the world do we ever get apple flavor out of this brew?"

"Elementary, my dear Watson. This solution evidently contains a bit of valeric acid judging from its B. O. So, we pour a small quantity of it in a test tube, add an equal quantity of ethyl alcohol and distil."

"Assistant to chemist: one-hole stopper attached to test tube containing glass tube leading to another vessel immersed in cool water. Ready for heat."

"Chemist to assistant: apply gentle, even heat."

"Assistant to chemist: no sooner said than done."

"Now you see, assistant, according to all rules and regulations, the liquid being condensed in the receiving tube should be ethyl isovalerate. And furthermore, whereas, acording to additional rules and regulations, should have a fragrant odor of apples . . . I wonder if it will . . ."

"I wonder . . ."

Trioxane In Quantity

➤ An old chemical, suitable for use in packaged fuels for campers, is now made by a new process that produces it in quantity. It is the 60-year-old trioxane, made originally by heating paraformaldehyde with sulfuric acid. The new trioxane is a stable compound, a polymer of formaldehyde, chemically alpha trioxymethylene.

The new process is a development of du Pont chemists. Facilities for trioxane manufacture on a commercial scale are now in operation at Perth Amboy, N. J. The product is a colorless, plastic, crystalline substance with a sweet odor resembling chloroform. It ignites instantly and burns with a hot, clean, odorless flame.

The principal industrial uses of trioxane will be as a solvent. In molten state, it is a solvent itself for many organic substances. In use, however, it will usually be dissolved in alcohols, ketones, ethers, esters or hydrocarbons. In the presence of water, it is a solvent for protein and zein.

New Slow Waves Occur Near Absolute Zero

New Sound in Liquid Helium

➤ A NEW KIND of sound has been discovered, but you won't be able to hear it. Called "second sound," the new sound is essentially a temperature wave which occurs only in liquid helium at a temperature only slightly above absolute zero.

"Second sound" was revealed by Drs. Cecil T. Lane, Lars Onsager and Henry A. Fairbank after extensive experiments with liquid helium in the Sloane Physics Laboratory of Yale University.

Although well within the range of normal hearing with a tonal frequency corresponding to about middle C, the new sound cannot be heard by the human ear. Apparently it occurs only in liquid helium and ceases when the helium's temperature rises above 2.2 degrees Centigrade over absolute zero, which is approximately 273 degrees Centigrade below zero. Waves of "second sound" travel at a speed of only about 70 feet per second compared with 700 feet per second for normal sound waves.

Temperatures within one-hundredth of one degree of absolute zero were reached in the laboratory experiments with liquid helium. Iron and steel at that temperature would shatter like glass.

Practical applications from studies of sub-normal temperatures might produce such revolutionary developments as a new alloy which would reduce electrical resistance and expand power transmission and a small but powerful atom smasher.

Other researchers have already developed delicate heat-measuring devices from low temperature research which may lead to more precise knowledge of the universe.

Heat causes vibrations which almost disappear at absolute zero. Experience with liquid helium and a temperature of absolute zero hold the possibility of greater application of the fundamental theories behind all modern physical research.

Helium is normally a gas, second only to hydrogen as the lightest known gas. Most difficult of all the gases to liquefy, helium was first produced in the liquid form by the Dutch physicist Onnes in 1908. He found that liquid helium boils at a temperature of minus 268.9 degrees Centigrade. The liquid bubbles like a fine wine and gives off a "steam" when exposed to the air.

Southeastern Alaska has several excellent sites where year-round hydroelectric power can be developed in commercial quantities for manufacturing.

Slender fluorescent lighting tubes up to 96 inches in length have been developed; they are the high-efficiency hot cathode type.

Hints for Your Lab

Improved Condensers

Distillation is essential in many chemical experiments but condensers are examples of tricky glass-blowing and therefore expensive. Two CHEMISTRY *readers have made their own condensers. Mr. Huisman's is simple and cheap. Mr. Craddock's is ingenious, being built out of ordinary apparatus and being portable.*

➤ THIS LABORATORY condenser, which I set up in my spare moments out of odd pieces of glassware, was tried out for distilling water and alcohol and running a few tests in organic analysis. It worked satisfactorily. It is small and portable, and does not have to be connected to a water tap.

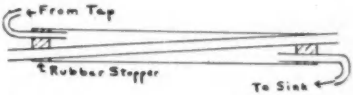
The apparatus consists of a 1" x 6" test tube of which the bottom has been removed by a glass cutter and two-hole stoppers inserted for the glass conections.

The water supply for cooling the condenser is furnished by a converted "automatic dispenser burette" of which the bottom section was utilized. Water is pumped up to the condenser with an air bulb.

The solution to be distilled can be admitted at any time thru the funnel (D) which is connected to the distilling flask by a section of rubber tubing closed with a pinchcock.

It is wise to grease all stopers before running the glass tubing thru. The amount of heat supplied by an alcohol lamp is advised as against the heat produced by a Bunsen burner. It allows the technician the better to watch the water supply in the condenser.

FRANCIS E. CRADDOCK



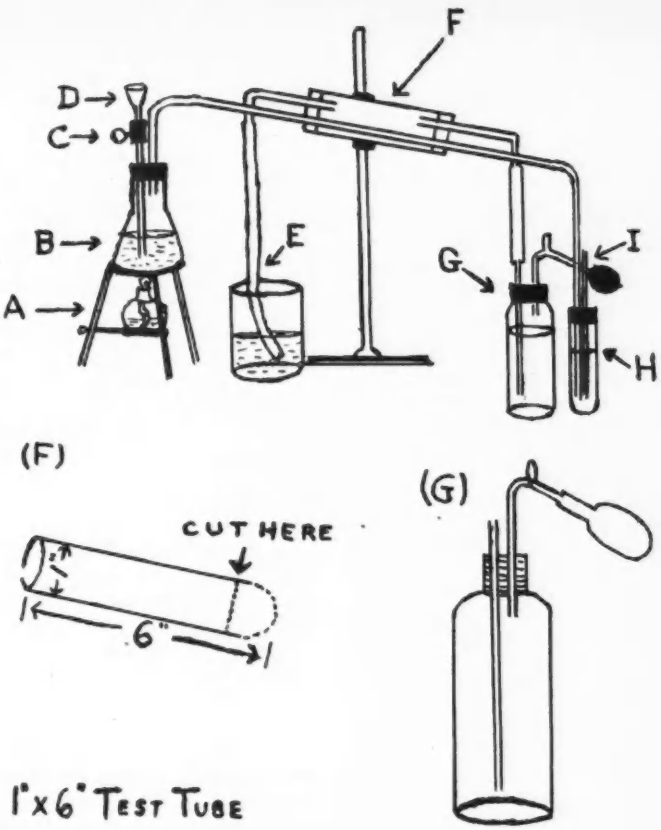
➤ MR. HUISMAN'S *condenser is easy to make.*

➤ HERE IS a simple, home-made condenser. The accompanying drawing is self-explanatory. The size of the condenser is, of course, entirely up to the reader. The length of the jacket of my condenser, including rubber stoppers, is 350 mm. The inner tube extends about 30 mm. on each side. I made the jacket of mine out of a discarded fluorescent light tube.

DONALD HUISMAN

➤ HINTS *to other laboratory enthusiasts as to useful apparatus they can improvise, short cuts that you have found helpful, or experiments and preparations you have enjoyed making are welcome here.* CHEMISTRY *will pay $2.00 each for descriptions of such experiments or apparatus accepted for publication. Contributions become the property of* CHEMISTRY.

Address contributions to CHEMISTRY, *Editor of Hints, 1719 N St. N. W., Washington 6, D. C.*



➤ Mr. Craddock's *set-up needs no gas and water pipes.*

(A) Tripod and alcohol lamp
(B) Flask for distilling
(C) Pinchcock attachment
(D) Funnel
(E) Beaker to catch waste water, which can be used over again
(F) Condenser made from a 1" x 6" test tube
(G) Water supply converted from an automatic dispenser burette, of which the bulb and glass attachments are utilized
(H) Receiver
(I) Escape valve which can be used as an overflow valve.

Petroleum Can Overcome Basic Chemical Shortages

Critical Chemicals

by J. OOSTERMEYER
President, Shell Chemical Corporation

Addressing the National Association of Purchasing Agents' thirty-second annual convention, the president of one of the great oil chemical companies tells them that petroleum will relieve some of their headaches.

➤ I THINK the keynote you have struck for this meeting — How Much?— When? — and For How Much? — is a very hopeful sign that you the purchasing agents and we the salesmen are at last on our way back to our normal business-like relationship. No one can say you have not selected the real, crucial $64 questions and asked them clearly, unmistakably and without waste of words. It is up to me to try to answer in like manner.

First of all, before I start out on a speech and particularly one in which I have to do a lot of explaining, I always like to define the field. Just precisely what do we mean by the chemical industry? Where does its responsibility for shortages begin and where does it end? What chance does it have to pass part or all of the blame for its shortages along to other industries?

I can answer these questions most easily in the reverse order. We in the chemical industry are in the worst position of any industry I know as far as passing the buck is concerned. Our responsibility starts with raw materials in their simplest and most abundant form—the gases of the air, the water of the sea, the sulfur and the coal and the limestone and the oil in the earth —and extends all the way to finished synthetic products such as rubber, dyes, plastics, fabrics and surface coatings. We don't even have many suppliers to blame, because most of the materials we use in our operations, such as acids, solvents and catalysts, are also chemicals which we are expected to make for ourselves. You might think that we would be allowed at least one loophole at the raw material end—that we should be in line for some sympathy when the supply of one of our starting materials runs out—but no!—you must not forget that we are the boys in the white coats with the magic microscopes and test-tubes. "If you can't get coal," they say "use sawdust. And if all the molasses is being kept in Cuba to make rum, just look at all those cornstalks!"

This should provide you with a pretty good idea of what the chemical industry is and the broad field in which it must accept the responsibility for shortages. I hope that in addition to making you all feel sorry for me starting out on this speech, I have gotten across the point that my subject should be of interest and concern to each and every one of you—not only to those who buy sulfuric acid or salt cake or epichlorohydrin but even to those whose purchasing is limited to much less interesting derivatives of

chemicals such as bathing suits, nylon stockings or lingerie.

We have just gone through—and, in fact, are still going through a period of severe shortages in many chemicals. To touch on them all, or even only those of major importance, would require much more time than I have been allotted here, and would, I fear, make a very dull and repetitive recital. Let me therefore select for examination only a few typical examples of the widest general interest, indicative of what I believe are significant developments and trends in the chemical industry today.

Types of Shortages

Now the basic or ground-swell movements in the chemical supply picture these days have superimposed upon them a lot of confusing ripples due to the generally upset condition of the post-war period. Let us try to get these types into their proper perspective by dividing chemical shortages into three types:

First, short-term shortages due to depleted inventories, pent-up consumer demand and momentarily high purchasing power. Every industry has the problem of contending with these shortages at the very time that it is struggling to reconvert from wartime to peacetime production, but I believe we all have them pretty well appraised by now and are seeing our way out of the woods.

Second, longer-term shortages due to demand exceeding production capacity, but not raw material supply. During the war, and in many instances because of the war, we developed new demands for many staple chemicals and found ourselves at the end of hostilities with inadequate facilities to meet them. This situation is being remedied as fast as we can throw up the additional plants or convert installations built by the Government during the war. Among the many examples of the shortages which will soon be alleviated in this manner are those in ammonia, methanol, formaldehyde, chlorine, caustic soda, soda ash, surfuric and other acids, and so on.

Third, and *finally*, we have the type of shortage about which I want to speak today—the really *basic* shortage which arises when the demand for a given chemical outgrows not only the productive capacity but *also* the supply of the raw material from which it is made—the type of shortage which, as I mentioned before, everyone expects the chemical industry to solve by turning to the sawdust and the cornstalks.

Well, we have a number of this third type of shortage with us right now. We have been worrying about them for some time, checking and cross-checking our statistics and our projections and our plots, and maybe we have not done as much about them as we might have, but then we did have a war on our hands and it came first in our thoughts and our work and our production. But now we are digging our way out, and the raw material which is coming to our rescue in case after case is not sawdust or cornstalks but petroleum.

I do not believe that any of my industrial colleagues will disagree with that statement or censure me if I give it considerable emphasis by my choice of examples in the discussion to

follow. Petroleum chemicals deserve all I am about to say about them—it is merely a coincidence that my particular company happens to be engaged in their manufacture. Any other speaker you might have selected would have to pay oil the same tribute for getting us out of some of our worst supply situations.

Alcohols

1. As a first example—a product with which I am sure nearly every purchasing agent in this room has come into contact at one time or another (and possibly even here at this meeting)—let me select *ethyl alcohol*. Now I should say right from the start that ethyl alcohol has a dual or Jekyll and Hyde personality, and should really be regarded as two separate and distinct chemicals. *Potable* or *beverage* alcohol, which is the form of ethyl alcohol that some elderly ladies of excellent intentions would have you regard as the Mr. Hyde side, is made from corn, rye, barley, wheat, grapes, fruit and, I believe, potatoes, one or the other of which appears always to be in plentiful supply if the price is right, and experience has proven that this is one product which is very hard to price out of the market. Over on the Jekyll side, however, *industrial alcohol* enjoys no such fortunate position.

Many of the large industrial users of ethyl alcohol would have to go out of business if forced to depend on the fermentation of expensive grains. Their principal source of supply has always been the relatively cheap blackstrap molasses, and over the years the price of blackstrap has been a matter of the greatest interest and concern. Today with demand outstripping the normal molasses supply, and the latter endangered by new ion-exchange methods of sugar refining which yield more sugar and less molasses, industrial alcohol has been as high as $1.00 per gallon, and the future would indeed look discouraging were it not for the presence on the scene of two new raw materials: wood wastes and petroleum gases. Two commercial plants for the manufacture of ethyl alcohol from wood wastes are now in operation in the Pacific northwest, following successful pioneering work in Canada and Germany. Synthetic ethyl alcohol from petroleum is not new, having been successfully manufactured in West Virginia and the Gulf Coast area for many years, but production will soon be greatly increased by at least one large new plant in Texas. It is my confident prediction that we shall see the present price drop and stabilize within the next year or two in the 30-40c per gallon range, at which firm level we shall all profit by the further development and growth of the many industries to which this is a vital intermediate or solvent.

2. The tight ethyl alcohol situation is also being relieved to an increasing degree by replacement by other alcohols derived largely from petroleum and natural gas. *Methyl alcohol*, which first came from wood, then from coke-oven gas, is being made from natural gas in all the new plants. Synthetic methyl alcohol, which will soon be available in plentiful supply at a reasonable price, is expected to displace ethyl permanently from such uses as anti-freeze.

Isopropyl alcohol is produced entirely from oil refinery gases and, at its stable price in the 30-40c per gallon

range, has been displacing ethyl alcohol from many uses such as lacquer solvents and rubbing alcohol. Very recently, *normal* propyl alcohol, also a petroleum product, has appeared on the market, and at an attractive price. This new alcohol will also undoubtedly capture markets which ethyl alcohol will have to come down in price to regain.

Solvents

This discussion naturally enough opens up the whole question of *solvents*. Solvents, in their quiet, unobtrusive way, have been the work horses of the chemical industry without which many of the striking advances in the fields of lacquers, finishes, plastics and synthetic fibers would never have been possible. We have come a long way from the day when a purchasing agent bought solvents from a short list containing such familiar names as wood spirits, petroleum ether, ligroin, naphtha and benzine spelled with an "i". Nowadays any one of a dozen suppliers will submit a thick catalogue filled with tables of data about miscibility, compatibility and kauri butanol values and will send his bright young men into your plant to prescribe a solvent or mixture of solvents to dissolve anything you have, carry it in solution just the way you want it, and lay it down whenever and at whatever rate you specify. The list gets longer every day, and an increasing number of the new entries is coming from petroleum. Avid though the demands may be, supply is catching up fast and bringing with it that boon to the purchasing agent, a reasonable and stable price structure.

3. From solvents it is an easy step into *finishes*, paints, varnishes, lacquers, enamels and coatings of all types. At the present pace of development in this important field, there were bound to be shortages—serious shortages—but these too are being met. Among the worst recently has been the shortage of linseed oil and of drying oils in general. Many measures are contributing to its alleviation. The planting of flax is being encouraged by the Government, and imports increased from such countries as Argentina. Soy bean oil is coming into the picture to a steadily increasing extent, and great things are being done with fish oils. A notable advance has been the application recently of solvent extraction techniques, old by now in oil refining, to the separation of natural oils into drying and edible fractions.

Most important, nowadays, among the finishes are the synthetic products such as the alkyd resins, and here is where we have run into a real ring-tailed shortage of the basic type I have been talking about—a case where we have had to find an altogether new raw material. One of the primary constituents of alkyd resins is a synthetic chemical which goes by the imposing name of *phthalic anhydride*, and the raw material from which it has traditionally been made has been naphthalene, a coal-tar product with which you may be familiar in the form of mothballs.

Well, when you make steel, you need coke—and when you make coke you get coal-tar—and coal-tar contains just so much naphthalene. As long as the steel mills keep going, and the naphthalene supply exceeds the demand for phthalic anhydride you are sitting pretty and the development and application of alkyd resins goes

merrily on. There is, however, no relationship between the consumption of alkyd resins and that of steel, and for some time now we have been watching a really striking rise in the former without any material increase in the latter. Today it is pretty well recognized that, although everything is being done to increase the recovery of naphthalene from coal-tar, the amount we need simply is not there and we must go to some other raw material for our phthalic anhydride.

Fortunately, research in the petroleum chemical field has come up with the answer, perfecting within the past few years the manufacture of phthalic anhydride from ortho-xylene, a component of gasoline. The first petroleum phthalic plant is now in successful operation on the West Coast, and oil refiners all over the country are busy extracting ortho-xylene from their gasoline while the phthalic producers are converting over from 100 per cent naphthalene operation as fast as they can. I am happy to state that from the very outset ortho-xylene has been made available at a price only slightly above the coal-tar by-product value for naphthalene so that the chemical industry can report with some pride that the day has been saved for alkyd resins as far as phthalic anhydride is concerned.

Glycerine

4. Now, in saying that the future of alkyd resins is assured as far as phthalic anhydride was concerned, I used the expression advisedly because these resins have simultaneously run into another of our serious basic shortages—that of glycerine, which is also a major component. Here again, as in the case of naphthalene, our national supply of an important chemical has been traditionally tied to another unrelated operation, the manufacture of soap from fats and oils. When fats are split or saponified the main product is soap, while glycerine is simultaneously obtained in a dilute impure solution from which it is recovered and purified whenever the operation is justified by the market demand and price.

Few chemical products have experienced the fluctuations in supply, and consequently in price, that have characterized the history of glycerine. In 1933, for instance, it was listed in the Oil, Paint and Drug Reporter at about 10c per pound and there were many idle recovery units around the country and quite a bit going down the sewers. In sharp contrast we have the situation today in which the same journal has been quoting glycerine for some time at prices above 50c per pound.

Glycerine has been short before, and has sold at high prices, but we have always pulled out of it. Will we do it again? I for one am inclined to doubt it, and, as I will point out in a moment, we are gambling fairly heavily on that judgment.

On the supply side, we have of course the very tight situation worldwide with respect to fats and oils which we will have with us for quite some time. Any chemical manufacturing process which is forced to compete for raw materials which are edible, or which can be made edible, is in for some tough going in the foreseeable future.

A shortage of fats and oils has naturally meant a shortage of soap, which I am sure you have all felt, but you may also have noticed that synthetic detergents, the so-called "soapless

soaps", many of them based on petroleum, have stepped into the breach and are doing a fine job. These products are now competing with soap on an equal price basis, while at the same time offering improved properties such as sudsing in hard water and absence of scum, and I do not believe they will ever yield their gains to soap again no matter what happens to the supply of fats and oils. And whenever less soap is made, there is less by-product glycerine to recover.

Now, let us look at the demand side of the picture. During the war, the requirements for nitroglycerine, the main ingredient of dynamite and of propellants for shells and rockets, increased greatly, and you will recall the waste fats drive when we were all called upon to help out in building up the national glycerine supply. This particular demand has, of course, been intermittent in the past and we naturally hope it will continue to be more and more so in the future, but the disagreeable fact that it may recur on short notice cannot be overlooked.

As the same time, however, we have been steadily building up non-military demands for glycerine which have not shrunk with the return of peacetime conditions, but which are certain to maintain and increase their growth. In addition to its use in alkyd resins already referred to, glycerine is needed in compounding cosmetics, softening cellophane, moistening tobacco, and several other equally promising lines.

So we have a condition of increasing demand and decreasing supply. What are we doing about it? Well, we are doing something we should have had the foresight to do some years ago. We are finally building a plant in which we will make glycerine synthetically out of petroleum and salt, both abundant raw materials—a step which will free a chemical of vital national importance in times of war and peace alike from dependence on the uncertain supply of a perishable raw material.

New Glycerine Plant

This $7,000,000 plant, which is going up on the plains of Texas just as fast as present-day conditions will permit, will not be ready until the Spring of 1948. I don't believe that we in the chemical industry can excuse ourselves for not being ready for the glycerine shortage one-half as plausibly as we can for the others of which I have spoken. The synthetic process was ready to go ten years ago. We should have been able then, or certainly in the years following, to anticipate the wartime requirements and to extrapolate the trends in industrial utilization so as to predict the present short supply.

It is easy, of course, to place all the responsibility on the supplier with the synthetic process. All he had to do was figure the future, put up his $7,000,000, wait a year or two while his plant was being built, and set out with his order book on a tour of flinty-eyed, hard-hearted purchasing agents, each with the old-fashioned notion that glycerine was something you could get for nothing if you bargained long and hard enough. Now we chemical suppliers are a hardy and adventurous breed, but there are some cases even in the chemical business when discretion is the better part of valor. We realized that it would be in the long-term interest of the whole industry to have synthetic glycerine, but we also realized that, interesting and important

though it might be, we were up against a case where the capital risk was just too great compared to the return which could be computed on the basis of past price performance even with a good "crystal ball" factor thrown in.

This is substantially what has held up synthetic glycerine. I do not believe I am violating any confidences when I tell you that it might not be on the way even now if we had not come across something new in what I might call industrial statesmanship. Some of the biggest buyers of glycerine—men who would be in the strongest position to ride the by-product price down when the time came—elected instead to take the enlightened long-range view and shoulder some of the supplier's unwarranted burden of risk by signing long-term contracts at a fair price. Had we had the vision and foresight to get together and do this sort of thing years ago there need have been no waste fats drive and there would be fewer gray hairs among the purchasing agents who are now scrambling for the short supplies of glycerine at high prices.

5. As a fifth and final example of chemical shortages and what we are doing about them, I should like to say a few words about what looks like it is going to be one of the most serious —the shortage of benzene.

Benzene

Benzene, or benzol, is what we call an aromatic hydrocarbon, and occurs, together with other aromatic hydrocarbons such as toluene and the xylenes, in coal-tar which for many years has been virtually their only source. Now just like naphthalene, which we mentioned in connection with the shortages of phthalic anhydride, benzene, toluene and xylenes are by-products of coking and have been sold in the past at whatever prices the market would support. Toluene and the xylenes have found uses as solvents and for many years coal-tar distillers were able to get prices in the neighborhood of 30c per gallon for them. Benzene, however, occurs in coal-tar in several times the volume of toluene and xylenes and the supply was always so greatly in excess of the demand that its price leveled off about 15c per gallon and most of it had to be worked off in motor gasoline. Now, remember that traditional coal-tar by-product price picture because I want to come back to it again. Remember also that it was fixed by supply and demand, since there is no other basic reason why there should be a 100 per cent spread among the values of three closely related aromatic hydrocarbons.

It was not until World War II that petroleum moved in to challenge the undisputed position of coal-tar as a source of aromatics. Toluene, you see, is the big T in TNT, and although coal-tar toluene got us through World War I with a little squeezing, it was obvious before the more recent unpleasantness got under way that this would be totally inadequate. Fortunately, we had learned how to make toluene from petroleum about 1939 so that new plants began to sprout up in oil refineries all around the country and by *April 1942* a single petroleum plant was producing more toluene than the entire coal-tar industry. Today a lot of these plants have closed down, but there is still enough petroleum toluene on the market to keep the price down around 23c per gallon.

I have indicated before that benzene, toluene and the xylenes are closely related chemically. Because of this, the petroleum plants can be modified without too much trouble to produce any one of the three. No sooner was the wartime toluene job complete, therefore, than they turned their attention toward the xylenes, which you will remember also used to bring around 30c per gallon. Today with petroleum xylenes available the quoted price is down with toluene at 23c per gallon, a firm level at which the oil people can keep some of their plants going at a reasonable profit.

Since the petroleum people in manufacturing aromatic hydrocarbons start with a raw material which has motor gasoline value, 15 cent benzene was comparatively safe from their competition. Not only is benzene as expensive to make from oil as toluene—it is actually somewhat more expensive due to the fact that the potential yield from a given quantity of gasoline is less—quite the reverse case from coal-tar, as you may recollect. So, with petroleum benzene in the 23-plus price range, the oil people naturally looked elsewhere and the coal-tar people kept meeting increasing industrial demands by pulling more and more benzene out of the big reserve pool which they were actually selling to oil refiners to put into motor gasoline in order to get rid of it.

Well, the industrial demands have kept on increasing and at quite a rate. We ran out of natural phenol some years ago, and have been making our new production synthetically from benzene. Phenol has been going into many products with expanding markets, but outstanding among them are the phenol-formaldehyde resins, from which we make telephones, electrical fixtures, plywood adhesives and many other things in everyday use. From benzene we also make aniline and all the aniline dyes. In the last few years, we have built up an enormous capacity for another important benzene derivative—styrene, which goes into synthetic rubber and polystyrene plastics. Then there are the synthetic detergents based on benzene and the popular new insecticides DDT and 666. I could go on further, but let me wind up with one more example of an important new product with large demands for benzene which I know has attracted the attention of every one of you at one time or another—nylon.

Demand Catching Up

We are fast reaching the point at which the coal-tar distillers will have no more benzene to work off in motor gasoline, and it will not be long before the oil refiners will be selling instead of buying. This is already foreshadowed by a steadily rising price, the last benzene quotation that I saw in the Oil, Paint and Drug Reporter being 19c per gallon. I have a very strong feeling that this is no short-term inflationary price rise, but simply a case of a chemical which has been in oversupply for many years finding its demand catching up and bringing it up to the general price level of comparable products.

I should like to be able to wind up my series of examples by telling you that in stepping in to solve one of our most serious shortages, petroleum was going to reduce the market price of benzene as it did those of toluene and the xylenes. Unfortunately, that is not in the cards, and we might just as well

readjust our time-worn ideas about buying benzene the chemical at the price of benzene the fuel. I will say, however, that there will be a point—which is not too far off—at which petroleum benzene will stabilize the price, probably just slightly above that of the other two related materials. As I explained before, I fail to see how, with petroleum economics providing the price fly-wheel, benzene can do otherwise than move from its familiar place at the foot of the aromatic table to the Number One position.

Research Needed

Well, I have done my best to pick out a few of the more serious and interesting chemical shortages, and to describe for you how we are going about solving them. I have tried to leave out as much of the white coats and magic test-tubes as possible, and still to convey to you a general impression of how fast things move in our particular business and how well equipped we must be with *laboratory research* well in advance of our immediate requirements, with *economic research* to define and interpret conflicting trends, and with *market research* to predict what products you fellows are going to want by the time we can get the plants built, what quantities you are likely to demand, and whether you will pay us enough at that time to enable us to recover our capital and earn a few dollars for our stockholders.

I have been too busy trying to answer your questions, How Much?—When?—and For How Much?—to give as much time as I would like to that last idea. Things move so fast nowadays that the time required to build a chemical plant looms very large against the rate at which demands grow or change, and it seems that no matter how sound the data on which you finally freeze a plant design, the chances are that by the time it is built it will be much too small or much too large or have altogether the wrong proportions of co-products to fit the market. This is where we frankly need help from you, the purchasing agents—all the help that you can give in the fullest spirit of co-operation to round out the projections of demand upon which we base our plans and risk our capital. This is not only a supplier's problem, for whenever there is wrong guessing and waste on the scale on which we operate today we all suffer—it is a problem for all of us, buyers and sellers alike.

Now I, as a representative of your chemical suppliers, have stood up before you today and tried to answer the questions you have selected as the theme of your meeting. It will not be long now before we suppliers will be coming around to see you, or perhaps sending you an occasional letter or a market research questionnaire in an attempt to gather information that we are going to need in laying our plans to anticipate and meet future shortages. All I ask, in the interest of all of us in the long run, is that you lend a sympathetic and understanding ear at that time to *our* questions—How Much? — When? — What Will You Pay?—and Will You Sign a Contract Now?

Silicious silicates are used in bicarbonate washing water to prevent the re-deposit on the clothes of dirt removed by the soap.

Holes Molten in Iron Ore

➤ Blast holes in iron are made rapidly with a new fusion-piercing method on the Mesabi Iron Range. The hole is made by a flame produced by burning a special flux-bearing fuel with oxygen.

Fusion-piercing is a patented process developed by the Linde Air Products Company of New York. A special blowpipe is used, and the flame, with a temperature of about 4,000 degrees Fahrenheit, is directed against the surface of the rock or ore.

Increases in drilling speeds with fusion-piercing of ten times that of older methods have been accomplished. Six-inch diameter holes up to 30 feet in depth were fusion-pierced at an average rate of 10 feet an hour in Minnesota taconite, a hard, tough abrasive, low-grade iron ore. Ordinary drilling pierces about one foot an hour in similar conditions.

In the new method, the high temperature of the flame causes some kinds of rock to flake off. Flux in the fuel causes other kinds of rock to melt. Pressure of the burning gases forces the molten material past a water spray where it is quenched and broken up. In the quenching process, water turns to steam which helps the gases force the quenched material out of the hole.

New Alloys Found Superior for Bearings

➤ Tin, nickel, silicon and copper in a new aluminum alloy give a superior material for bearings in internal combustion engines whether for land vehicles or aircraft.

This is the conclusion drawn from extensive tests made recently and reported at the meeting of the Society of Automotive Engineers by H. Y. Hunsicker and L. W. Kempf, of the Aluminum Company of America, supported by G. B. Grim, of the Caterpillar Tractor Company, and E. L. Dahlund, of Fairbanks Morse.

The two latter said that the new aluminum-alloy bearings appear to resist wear, as well as damage by foreign particles, and to support vastly greater loads for prolonged operating periods.

Bearing materials composed of small proportions of tin, nickel and copper, with the rest commercially pure aluminum, were said by Messrs. Hunsicker and Kempf to give superior performance in engine service under extreme loads at high temperatures. These bearings, they explained, resist damage by particles of bronze and steel, which they absorb, and show high resistance to corrosive attack by organic acids released by lubricating oils.

The addition of silicon, they stated, improves the anti-frictional and anti-scoring properties of the new material. Under boundary and thin-film lubrication conditions, they asserted, the bearings accommodate much greater loads than do bearings of bronze, babbitt, and copper-lead.

Collecting Rocks and Minerals Makes Inexpensive Hobby

Geology At Your Doorstep

➤ ROCKS AND MINERALS are indicators used in the larger science of geology. From the nature of the rocks, you can learn what happened at the time of their formation; from the minerals in the rocks you can find out where the raw materials came from.

Collecting of rocks and minerals is a fascinating hobby, one which can be continued for years, even in an area of a few square miles around your home, without running out of materials.

Minerals are the crystalline materials rocks are made of. They usually have a very definite shape, a characteristic color, and a specific hardness. Size of the crystals means nothing. A crystal of yellow iron pyrite may be perfect although it is hardly large enough to see, while another may be two inches across a side.

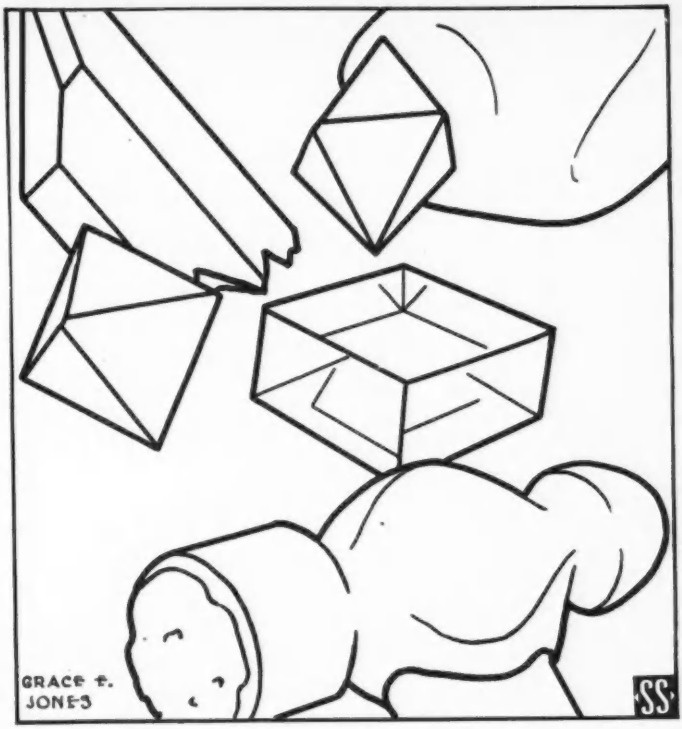
When mineral specimens are collected, they should be attached to a note telling exactly where they came from, wrapped to prevent scratching of the crystalline surfaces, and stored in any convenient box, unless a corner of a bookcase or something similar can be used to house the collection. Do not pick out the small crystals so commonly found in "nests" in rock. These groups of crystals are more interesting if collected with the rock holding them.

Rocks are groups of minerals, containing many crystals of several kinds, or many fragments of crystals. Sandstone, for example, is composed of quartz grains cemented together, often with iron rust. Rocks are usually collected in "hand size" specimens, roughly three by four by one inches, and may be chipped down to this size with an old hammer. Don't use a good carpenter's hammer for this work, or it won't be good very long. Rocks, like minerals, should be immediately labeled, telling exactly where they came from. If the classification is uncertain, that can be made later.

There are three general kinds of rock—igneous rocks, that melted in the depths of the earth and hardened in their present positions, like granite; sedimentary rocks, made when sands and muds hardened, like sandstone; and metamorphic rocks, made when either igneous or sedimentary rocks have been buried and heated and later exposed. The flaky mica-schists of the East are a good example of the latter.

Identifying rocks and minerals is even harder than determining the species of plants or animals, as there are literally thousands of different kinds of rocks and minerals. However, a few of the more abundant kinds of rocks can be rather sketchily indicated.

Granite is a "speckled" rock, usually gray or reddish-brown, very hard and tough. Some of the oldest rocks are granite. It is found in mountain-



ous regions, and also as loose boulders in the Midwest. Also a very ancient kind of rock but finer-grained, basalt is very dark and heavy. The Palisades of the Hudson are made of basalt.

Another fine-grained rock is limestone. It is usually white or a dirty gray and is normally found in rather thick, flat-lying layers or strata. It fizzes if you put hydrochloric acid on it.

Sandstone, ranging in color from white through yellow and red to dark brown, is made of sand grains cemented together and therefore may be either coarse or fine-grained. It is normally found in flat beds like limestone, but the white sandstone may be distinguished from limestone by treating the rock with hydrochloric acid; sandstone does not fizz.

Look at roofs or your school blackboard to see slate. But don't get the idea that all slates split in thin layers; some come in massive blocks. Slate was fine-grained mud or clay before it hardened into rock.

Marble, used widely in building,

was formed when limestone was put under great pressure and heat in ancient times. It may be white, black or almost any color.

Lavas may be anything from dark, heavy, solid material to fluffy light-gray pumice-stone that will float on water. Rough edges and glassy sharpness are especially characteristic. A particularly striking kind of lava is like black glass; it is known as obsidian.

Stretching Rubber Unwinds Coil

➤ STRETCHING a rubber band is like pulling out a loosely-coiled ball of twine, according to Dr. Raymond M. Fuoss, Sterling Professor of Chemistry at Yale University.

The molecules of the naturally-occurring polymer, which is rubber, are actually linked end to end in the form of long chains fastened together by pairs of carbon atoms. In effect, these pairs of carbon atoms form swivels at which the chain can rotate freely, with the result that a given polymer molecule can exist in an enormous number of geometrical configurations.

"Between the highly improbable extremes of a perfectly oriented, fully extended chain and a tightly coiled densely packed ball-of-twine structure," Dr. Fuoss explained, "there are many configurations, describable as loosely coiled, and among these is a most probable range of configurations.

"Consequently, when we stretch a rubber band, we are not doing work against internal lattice forces as in the case of crystalline compounds, but we are moving the various chains into less probable, more highly extended configurations. When the external force is released, the individual molecules diffuse back, under normal thermal motion, to their preferred configurations."

Cloth Stains Easily Removed

➤ STAINS on clothes, from tea, coffee, iodine, ink, grass and other substances, are easily removed by means of two new wax-like sticks recently patented. They contain a type of alcohol.

The process is simple. The fabric is laid on a clean undercloth and sponged; then what is called the acidic stick is daubed on until no more stain appears on the undercloth. After again rinsing the spot, the second stick, a reducing stick, is applied and and the spot disappears.

The chemicals used in the wax-like sticks are based on what is known technically as polyethylene glycols. Glycol is an alcohol, but not the ordinary type. Chemically it is between ethyl alcohol and glycerine, which is also an alcohol. The acidic stick contains an acid salt of oxalic acid and tri-enthanolamine, a product made by treating ethylene with ammonia. The reducing stick contains powdered sodium bisulfite or other reducing material.

These and a new tarnish remover are developments of Carbide and Carbon Chemicals Corporation.

Bright Ideas of Chemists
Patented in Recent Weeks

Inventions Interesting to Chemists

Patents may be ordered by number from the U. S. Commissioner of Patents, Washington 25, D. C. Complete specifications cost 25 cents each. Send coin or money order, not stamps.

▶ WITH SPRAY WARFARE on flies, mosquitoes, ragweed, poison ivy and other pests in full swing this summer, a new piece of mobile heavy artillery is offered by E. O. Keathley of Tiptonville, Tenn. for patent 2,424,468. It is a spraying apparatus consisting of a pair of tanks mounted on opposite sides of the hood of a tractor. The pump is mounted on the rear axle and powered through a rear take-off pulley.

Something to use in this and other spray apparatus is covered by patent 2,424,220, granted to E. W. Bousquet of Wilmington, assignor to E. I. du Pont de Nemours and Company. It is an insecticide in which the active ingredients are one or more amides of 3,6-endomethylene-4-cyclohexene-1,2-dicarboxylic acid. Undoubtedly a more manageable symbol or trade name will be used when this is ready for marketing.

Peanut Fibers

▶ PEANUTS join the procession of protein sources used for the production of synthetic fibers and fabrics, in patent 2,424,408, issued to Sarah N. McGeoch of Greenford, England, and assigned by her to Imperial Chemical Industries, Ltd. The peanut globulin is extracted with strong alkali at moderately low temperature.

New Electron Microscope

▶ A MORE COMPACT type of electron microscope, which uses electrostatic fields instead of the more commonly used magnets for focussing its electron beam, is the invention offered by two General Electric Company physicists, Dr. Charles H. Bachman and Simon Ramo, for a series of four patents, 2,424,788 through 2,424,791. An outstanding advantage claimed for the new design is that the vacuum chamber is small, thereby reducing the time needed for evacuating between changes of specimens. Patent rights are assigned to the employing corporation.

"Humigrid" for Refrigerator

▶ AN ELECTRIC REFRIGERATOR with accurately controlled humidity is the claim advanced by Wilson P. Boothroyd of Philadelphia for patent 2,424,735, which he has assigned to the Philco Corporation. Control is effected by means of what he calls a "humigrid." This is a plate of glass or other non-conducting material having on it a grid of thin platinum ribbon. Resistance to flow of an electric current rises when the humidity goes up, falls when humidity decreases. These changes can be used to turn on and off the necessary humidity control mechanism.

No More Pink Codfish

▶ NOT EVEN the most radical of leftists likes pink salt codfish. Yet this is always a possibility, because fish

processors use sea salt, and sea salt often harbors a bacterial species that turns it red or pink. Comes now Herbert Hempel of the famous fishing town of Essex, Mass., with a chemical discourager for this troublesome microorganism. He mixes about 0.5% of sodium acid phosphate, finely powdered, with the dry salt. On this improvement he has obtained patent 2,424,615, which he has assigned to the Gorton-Pew Fisheries Company of Gloucester.

Solvent Picks Out Acetylene

➤ ACETYLENE, one of the most valuable of industrial gases, can be concentrated out of the mixture of carbon monoxide, methane and other gases resulting from one production method by passage through a derivative of furfural which has a selective solvent action for this one particular gas. Discovery of this useful property in the solvent won patent 2,424,987 for Dr. Robert M. Isham of Okmulgee, Okla. Best compound for the purpose is tetrahydrofurfuryl acetate. Patent rights are assigned to Danciger Oil and Refineries, Inc., of Fort Worth.

Photocell Detects CO

➤ CARBON MONOXIDE, which can be even more dangerous in airplanes than it is in automobiles, is detected photoelectrically in the device on which patent 2,425,059 has been awarded to William F. Fagen of Chicago, assignor to the Stewart-Warner Corporation. A continuous sample of the air supplied to the plane's cabin is passed through a tube containing a gel that turns dark blue in the presence of carbon monoxide. A light beam that passes through the gel in its normal state is dimmed, hence fails to excite the photocell on which it is directed. This change in current, suitably stepped up, operates a relay and gives warning.

Rosin Plastic

➤ ROSIN is polymerized into a firm, chemically stable plastic of high melting-point through the use of the bromine or chlorine salts of mercury as catalysts, in the process on which B. L. Hampton of Jacksonville, Fla., has been granted patent 2,424,979. These catalysts replace the halides of tin and zinc used in an earlier process. Patent rights are assigned to the Glidden Company of Cleveland.

Mirror Back Coating

➤ BETTER PROTECTION for mirror coatings is provided in patent 2,425,011, issued to James H. Smith of Vallejo, Calif. He covers the back of the mirror with a chlorinated rubber solution.

Orange Cosmetic

➤ BECAUSE SOME varieties of oranges are not orange when they are fully ripe, it is considered legitimate to dye their skins to a more attractive hue. An improvement in this cosmetic treatment, consisting of a thin wash of a wax in which an oil-soluble pigment is dissolved, is protected by patent 2,425,073, granted to J. N. Sharma of West Los Angeles, Calif.

Gur is a crude type of unrefined brown sugar produced in India; it contains about two-thirds as much sucrose as factory white sugar but is used in large quantities because of its lower cost.

Tissue Reactions to One Chemical Inhibited by Presence of a Second

Metabolite Antagonists

—Reprinted from "For Instance," American Cyanamid Company

▶ EXTENSIVE INVESTIGATIONS in chemistry and biology may sometimes come to a logical stop at clearly-defined boundaries; more often, however, they are like the explorations of endless caverns where any obscure passage may open into new caves whose dimensions stretch beyond the reach of the entering torches. Thus, in the course of the spacious studies of the 'sulfa' drugs, there was found a striking antagonism between them and the metabolite, p-aminobenzoic acid, whose presence had a curious suppressive effect on the biologic activity of the sulfas. Metabolites are substances essential to the conversion of food stuffs to living tissue but under certain conditions other substances are apparently able to neutralize their action. Such cases of antagonism are not reactions of chemicals on each other as when an acid is neutralized by a base; rather the story is one of tissue reactions to one chemical being inhibited by the presence of a second. Modern science knew of several pairs of metabolite antagonists but sulfa drug research uncovered a new group and started a search for the principle involved in such behavior.

The antagonisms turn up in diverse fields. A few compounds which seem mutually remote excite them, but some compounds which are chemically closely related excite them too, and the relation of p-aminobenzoic acid to the sulfas is a case of the latter. The phenomenon occurs in enzymes, the basic units of living processes, in the low forms of life known as yeasts, and also in the life processes of blood parasites, bacteria, animals and man.

Yeasts will sometimes poison themselves, producing products of growth which turn and inhibit further growth, and the conditions and chemicals which seem to instigate such suicides have long been a field of study.

In the higher forms of life, the vitamins provide a series of cases.

Biotin, a recent addition to the known vitamins, is essential to growth of yeast but raw whites of eggs contain a protein substance, graphically baptized avidin, in whose presence biotin seems unable to promote growth.

Vitamin K sustains the clotting property of blood but dicumarol, an anti-coagulant derived from spoiled sweet clover hay, used simultaneously, will somehow block its normal action. The mechanism of this action on the living cells is yet to be learned.

The fatally toxic action of pyrithiamine in animals can be prevented by the vitamin, thiamine, of which it is an analogue.

Another vitamin, pantothenic acid, has antagonists in some of its analogues; it is now disclosed that hemolytic streptococci will grow in the test tube and certain malarial parasites

will grow in the blood of live chickens if they find there the pantothenic acid necessary for their growth, but will be inhibited if certain of its analogues, such as the pantoyltauranilides, are also present in adequate amounts.

Some of these antagonisms are now considered to be the results of competitive inhibition of an enzyme or tissue receptor associated with a metabolite. The emergence of this principle is enough to keep biological chemists busy for a generation on this new frontier!

Free Material Offered Science Clubs

A THIRD of a million young scientists in more than 14,000 science clubs are beginning a new year of science activity as members of Science Clubs of America.

This fall every science club, through its sponsor, is receiving a Science Clubs of America Handbook of over a hundred pages. This book, full of information on science club activities, is supplied free to teachers and others who act as sponsors of science clubs and affiliate them with Science Clubs of America, which is a Science Service activity. To non-sponsors, the book is available at $1.00 per copy.

Included in the SCA Sponsor Handbook, are chapters upon How to Organize a Science Club, suggested activities for the club, how to get publicity, projects that can be undertaken in co-operation with national organizations and government agencies, an extensive list of free and low-cost materials, lists of books in all fields of science, information on the Seventh Annual Science Talent Search for the Westinghouse Science Scholarships, and an extensive list of aids available to science clubs from Science Service.

Prominent in the programs of most of the clubs are projects that involve some phase of Chemistry, either as a major activity or as an adjunct to other fields of experimentation.

Younger members are usually interested in a variety of science fields. Therefore, a General Science Club in which they study any or all fields of science is appropriate.

Members past the age of 14 or 15 have usually settled on a few fields of specific interest. They want to have clubs devoted to chemistry, microscopy, radio, photography or similar specialized subjects.

Your club can do such things as: learn the science in your city, plan excursions, arrange talks and demonstrations, review science books, study science biographies, encourage individual research projects, etc. Club members can participate in a science congress, science fair, photographic salon and other interesting activities.

Write today to Science Clubs of America, 1719 N Street N.W., Washington 6, D. C. to get this free help for your club members.

Eucalyptus seedlings, totaling some 9,000,000, have been distributed to farmers in Sao Paulo, Brazil, to produce firewood; they will be ready for cutting in three to four years.

Thymine, Synthetic Chemical For Anemia

▶ STRIKING ANTI-ANEMIA properties of a synthetic chemical called thymine were reported by Dr. Tom D. Spies of the University of Cincinnati at the annual meeting of representatives of foundations and philanthropists aiding in financial support of the university's nutrition studies at Hillman Hospital, Birmingham, Ala.

When thymine is given in pernicious anemia, the patient who had so long been pale, listless and weak then experiences a sudden and dramatic increase in his strength, appetite and vigor, Dr. Spies reported. He now sits up in bed and insists he is strong enough to go home and to work.

Red blood cells which have been arrested in their development in the bone marrow of pernicious anemia patients form huge islands of regeneration and within three or four days after treatment is begun, new cells begin pouring into the blood.

Thymine is not to be confused with thiamin, which is also called vitamin B_1. Thymine is a part of nucleic acid, Dr. Spies explained, and gets its name from the fact that it was first isolated from the thymus gland.

Good results in pernicious anemia have also been obtained with a vitamin, folic acid, Dr. Spies reported. While the two chemicals have a similar effect, doses of synthetic thymine must be several thousand times as large as those of synthetic folic acid.

Pernicious anemia patients heretofore have been treated with liver, discovered in 1926 to be effective in this ailment, and with liver extract, brewer's yeast and ventriculin.

Stained Bacteriophage Seen Through Microscope

▶ BACTERIOPHAGE, formerly invisible foe of disease germs, has now been seen through an ordinary light microscope, Dr. Alvin W. Hofer, of the New York State Agricultural Experiment Station, Geneva, N. Y. and Dr. Oscar W. Richards, of the Spencer Lens Company, Buffalo, report.

When the electron microscope made it possible to see bacteriophage particles, scientists found that they were larger than the flagella of bacteria. Since the flagella, tiny whip-like affairs extending from bacteria, can be stained and seen under ordinary light microscopes, it seemed reasonable to suppose bacteriophage particles could, too.

This has now been done. First the bacteriophage was treated with auramin, a dye, and radiated with ultraviolet rays. The bacteriophage particles then appeared through the microscope as bright yellow pinpoints of light in an otherwise dark field. With further study, Dr. Hofer and Dr. Richards developed two more methods for making bacteriophage visible. These involved the use of stains, or dyes, one a modification of the acid-fast stain, and ordinary light.

With these methods and use of the new phase difference microscope, the scientists were able to work out the order of events in bacteriophage destruction of bacteria.

Onions, Beets and Flowers Yield Rich, Warm Colors

Dyes of the Primitives

by MARTHA G. MORROW

➤ THE GREEN STAIN of grass across your shirt or the red juice of berries on your dress may spell trouble to you because it is hard to remove—but to your ancient ancestor it may have suggested a new source of color.

Many ancient dyes were discovered entirely by accident. The earliest dyes were probably stains from berries, fruits and nuts. Early man liked the color of the stain, discovered it lasted despite the sun and rain, and began to use it to dye his fabrics.

Later flowers, leaves, stems and roots of shrubs, bark and twigs of trees were found to be good sources of dye. Primitive people of almost every country seem to have developed their own favorite dyes.

At first, dyestuffs of vegetable origin, available in the neighborhood, were the only ones used. The primitive dyer merely collected flowers, berries, leaves, bark and roots in nearby fields or forests, and boiled them in water to extract the dye. Colors were limited pretty much to red, yellow, green, blue and brown. Few variations in shades and tones were possible.

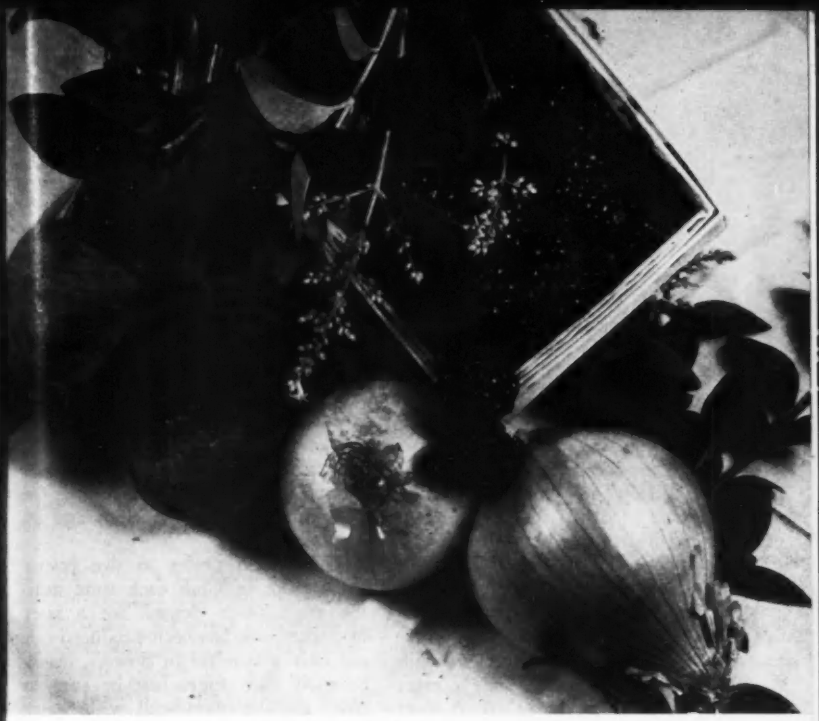
In time, however, some dyes proved more satisfactory than others. Sometimes this was because the colors were more pleasing, sometimes because they lasted longer. As dyestuffs found in one district were recognized to be superior to those of another, dyestuffs were imported from neighboring regions and trade in them began. Eventually many of the dyestuffs used in ancient times were eliminated as unsatisfactory, so that only a few survived the test of time.

Natural dyes are seldom used today. Chemical dyes, discovered in recent years, have proved so popular that there is little demand for the old-time favorites such as indigo (blue), madder (red), woad (blue), logwood (purple) and fustic (yellow). But many people interested in weaving and embroidery insist that the materials be dyed with natural dyes, valuing the colors for their richness and warmth.

The gay goldenrod blooming in the field or along the roadside is an excellent source of dye. The fresh, bright flowers give a lovely yellow-orange. But dye can also be secured from the faded flowers that have passed their prime or from the dried-up petals that remain on the stalk long after frost. The color, though perhaps not so brilliant as that secured from the fresh flowers, is pleasing and lasts well.

A burnt-orange dye can be secured from the dry brown outer skins of onions. Tea leaves produce a lovely rose-tan. Twigs pruned from apple trees may be used to dye cloth a golden yellow.

Some dyes give their color directly to the wool without any pre-



▶ ONIONS, *beets and berries may be tried as sources of dyes for cloth. Dyeing was an ancient chemical industry long before the coal-tar dyes were made.*

liminary preparation. For others, the fiber must be specially prepared before it can take the color. Because the auxiliary chemicals make the dye "bite" better into the material, they are called "mordants." This comes from the French word *mordre*, meaning *to bite*.

Alum found in local mineral deposits was used by the Egyptians, Chinese, Greeks and Indians of both America and Asia as a mordant. Today potash alum is considered an excellent mordant. Cream of tartar is frequently used with it to brighten the color. Another popular mordant is potassium dichromate.

A given dyestuff can be made to produce a variety of shades or even different colors by using different mordants. Dahlia flowers used with a chrome mordant, for example, on wool produce an orange color. But a light yellow is obtained with alum.

To obtain the desired color or shade, it is often necessary to dye one color over another. Green is produced by dyeing the cloth blue with indigo,

then dipping the wool in a dye obtained from goldenrod flowers. To get a light terra cotta, some experts obtain a brass shade from broomsedge, then top-dye the cloth with madder.

Good black dyes are difficult to obtain. Black can be produced, however, by dipping a piece of wool mordanted with alum in the indigo vat, then dyeing it in the brown obtained from walnut hulls. If iron salts are used, black dyes can be made from oak galls, sumac leaves or other plants containing tannic acid.

Pastel shades are the ones most frequently produced with vegetable dyes. Yellow and brown are most likely to be obtained by an amateur experimenting with easily available plants. The better vegetable dyes last well and are improved by the mellowing touch of time.

The amount and intensity of a dye obtained from a plant often vary with the age of the plant. The younger ones usually give a weak dye. A plant with a great deal of water in it usually gives a dilute color. Plants collected in the fall do not necessarily produce the same shade as those collected from exactly the same locality in the spring. It is difficult to duplicate the exact shade of a vegetable dye.

The color of a flower is no guide to the shade of dye it will produce. Brightly colored autumn leaves are not a source of dye. Berries are often disappointing.

A dye that is fast on one fiber may not be so satisfactory on another. Or it may be fast when dyed by one method and not at all fast when applied by another. Of all the textile fibers, wool is the best. It can be dyed easily and the resulting colors change the least. It combines with practically all dyes.

For those who want to discover for themselves which plants are a good source of dye, here is a standard recipe that can be tried on almost any plant part, be it blossom, leaf, root or bark. For each pound of cloth, use a peck of fresh dye-plant. Crush or tear into small pieces, then cover with water and soak overnight. Boil the plant for about an hour, then strain off the colored broth. To this dye extract add enough water to make four gallons for the dye bath, place the wool in the liquid and simmer for 30 minutes. Rinse the cloth and let dry.

Those who prefer to dye just a small piece of cloth each time until the exact shade desired for a scarf or pocketbook has been produced can use only a handful of flowers, leaves or roots each time. Just be sure to cover the dye-plant well with water when you let it soak overnight and replace the water as it boils away.

A large number of natural dyes require a mordant. Madder, for instance, produces no color on the wool unless alum, chrome or some other mordant is used. The lovely gold dye of privet leaves is entirely lost if a mordant is not employed.

One of the simplest mordanting recipes calls for four ounces of potash alum, one ounce of cream of tartar and four gallons of water to each pound of wool. After the alum and cream of tartar are dissolved, the wool is immersed in the solution and heated gradually to a boil. After boiling for an hour, it is allowed to cool

▶ INFUSIONS *of roots, leaves and flowers give soft colors, many of them permanent. It is interesting to experiment with a variety of plants.*

and the wool remains in the mordant overnight. Then the liquid is squeezed out, the wool rolled in a dry towel and placed in a cool place until ready for use.

The fastness or permanence of a dye is important, but no dye is absolutely fast under all conditions. It may be fast to light or to perspiration or to washing, but not fast to all three. A number of simple tests, similar in principle to those used in testing cloth professionally, can be applied in the home.

A series of cut-outs will show whether a color will fade in the sun. Cut openings an inch square in two pieces of heavy cardboard. With gummed paper fasten the dyed cloth to one of the pieces so that the cloth shows through the cut-out. Cover the cloth with the other piece of cardboard, being careful to have the openings correspond so the light comes through the fabric. Put the frame in the direct sunlight and tilt toward the sun. After a dozen sunny days, comparing the area exposed to the sun with the protected portion will show if the dye is sun-fast.

A two-inch square of dyed wool sewed to a similar piece of undyed wool will help show how water affects the dye. If this is placed in a fruit jar partly filled with soapy water and shaken thoroughly for about a half hour, you can pretty well tell how it will withstand washing. After the water has been squeezed out and the sample rinsed a number of times and ironed dry, unsatisfactory colors will have faded or "bled" onto the undyed piece.

The late summer or autumn garden offers a wide variety of natural dye sources. A large number of experiments has been worked up for the benefit of those interested in obtaining dyes from what is available in and around the home.

Every month our members get an unusual box or bulky envelope containing scientific material—novel, intriguing, surprising.

THINGS OF SCIENCE kits are assembled especially for those who are not satisfied by merely reading words and seeing pictures. The Vegetable Dye unit of THINGS OF SCIENCE gives you samples of natural dyes in the three standard colors, red, blue and yellow, and a package of mordant to use with them. Twenty-two fascinating experiments are described in the accompanying booklet, taking you from the status of the rankest amateur to the point where you can sport a scarf or bag dyed with plant colors you have discovered and produced for yourself. The packet which will introduce you to this artistic pastime, with full explanation and background information, is yours for only 50c. Or send $4.00 for full year's membership in THINGS of Science (12 kits of specimens and experimental material, a different one each month) and receive in addition the Vegetable Dye unit FREE.

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